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THE

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TELEPHONE EXCHANGES AND THEIR WORKING.

AFTER carefully reading the paper which Mr. Dane Sinclair, engineer-in-chief to the National Telephone Company, brought before the notice of the Institution of Electrical Engineers on the 26th ult., one at first sight feels somewhat at a loss to see its real purport. The paper, which we publish in another part of this journal, does not, so far as we have been able to perceive, add anything to the knowledge of the up-to-date telephone engineer. It advances no new suggestions for better telephone working, nor does it throw any light upon the indifferent service with which subscribers have now to be content; indeed, after a few sentences of preamble it resolves itself into the solitary subject of switchboards, so that apparently the only point left for its *raison d'être* looks suspiciously like a half-hearted onslaught upon multiple switchboards as usually constructed, and an equally lukewarm recommendation of the flat-board, of which Mr. Sinclair is the pronounced champion.

Before attempting to follow Mr. Sinclair into the arguments with which he tries to make out a good case, we would question the policy of introducing into a technical paper such very unwarrantable allusions to American inventors as the following: "To overcome the difficulty they invented what is known as the "multiple" board, the possession of patents for which must have given the owners very considerable satisfaction, as well as yielded them enormous profits"; and "In this connection I may mention that the multiple system was independently invented by an employé of the United Telephone Company, but subsequently to the date of American patent."

It is unfortunate that the employé referred to was anticipated by somebody else—by no means a rare occurrence in patent matters, as everybody knows—but that is no reason for failing to recognise the good fortune of the owners of the multiple-board patents, or the advantages they have conferred upon users, and such allusions might well be spared in dealing with subjects of a purely technical character.

The telephone, that "scientific toy," has become a great factor in the transaction of business, a mighty power in the land, and its commercial success is not the least gratifying feature in its development; to this, more than anything else, American ingenuity and the multiple board have conduced, so indirectly, therefore, Mr. Sinclair may attribute the position he now holds to the foresight and energy of the very people he treats so cavalierly. It is not wise to look a gift-horse in the mouth, and those who know Mr. Sinclair's readiness to give credit where credit is due, will look askance at such references to inventions which have done so much to make telephony what it is.

The problems in switchboard work, according to Mr. Sinclair, have always been, how quickly can a connection be made, and how can efficiency be best obtained?

The answer to this, if we have correctly grasped the gist of the paper, is by adopting for exchanges with from 2,000 to 8,000 subscribers, Mr. Sinclair's flat board, together with the "call wire."

Mr. Sinclair's arguments, *pro* and *con*, may be summed up as follows:—On the multiple board principle the number of jacks necessary in an exchange increases, in proportion to subscribers, in an amazing manner, and he gives figures in support of his contention; that the number of soldered connections for an 8,000-line exchange is more than half a million in excess of what is required for a flat board; and that it is difficult to find switch-rooms large enough in many cities to accommodate such boards; whereas, with a flat board, a smaller number of jacks, and less cable, are required, better talking is ensured, fewer faults occur, and only half the floor space required for upright boards is taken up. We need only draw attention to one of the objections; the others will doubtless be fully met by telephone engineers when the discussion takes place. Mr. Sinclair pointed out to his audience, as electrical engineers, how forcibly his contention for the efficiency of the flat board was brought before them by the reduction in the number of soldered connections. We confess we fail to realise its vast importance.

To the electric light engineer, thinking only of his mains, it would naturally appeal; to the telegraph engineer it would also be a consideration, but in a less degree; but to the telephone engineer we doubt whether it matters one way or the other. If it can be shown that upright multiple boards are better adapted for quick connections, and are more efficient than those on the flat, and we think that the back numbers of the Electrical Review will convince most people that this is the case, Mr. Sinclair's bogey of more or less soldered connections will carry no real weight, for there should be no difficulty in making any number of perfectly reliable joints for telephone currents.

His illustration of the common sense and patience of the long-suffering telephone subscriber on the "Call wire" is scarcely happy. "A subscriber coming on to the call wire and hearing others talking to the operator does, as he would do, if booking a ticket at a railway office, *i.e.*, take his proper turn." Mr. Sinclair seems to forget that if the railway passenger finds a crowd around the ticket office, there is a way out of the difficulty by paying at the other end. He then goes on quite gravely, and in the spirit of the individual, who, not being an Irishman or a bird, couldn't be in two places at once, to tell us that "it must be clear to everybody that an operator cannot attend to two subscribers at the same time, and generally it is quite as satisfactory to a subscriber to listen until he hears that the operator is free, as to ring time after time until the operator is able to attend to his call." And it is under these circumstances that Mr. Sinclair expects common sense, as in all matters of business, to prevail!

Whatever may have been the author's real intent when submitting his paper to the Institution, and we have stated plainly the impression it has given us, we think that there is but little bottom in his arguments on behalf of the flat board.

BOILERS AT ELECTRIC LIGHT STATIONS.

Our contemporary, the *Engineer*, in discussing the reasons that have led to so extended a use of water tube boilers in electric light stations, endeavours to trace a cause for the large use of these, and of locomotive type boilers, in face of the fact that all the largest steam users in the country persistently adhere to the Lancashire type. We have heard the water tube boiler called the Professor's boiler, perhaps because it has been largely used by trading professors, and the practice has been followed by their pupils, many of whom had had little opportunity of studying the older types of boilers in their daily work. There are other reasons, also. Most early installations of the electric light were temporary affairs at exhibitions, or problematical, as the early lighting of the town of Chesterfield, and everything was made as removable as possible. Then followed the craze for the cellar boiler, so dear to the average architect, and the water tube type was carried in piece-meal. There was also, as our contemporary points out, great ignorance as to the high pressures carried at sea in boilers with flat ends and barrels much larger than any Lancashire boiler ever constructed. Indeed, the largest of this type ever made had a diameter of only 12 feet, and but two were constructed, probably because of the difficulties of land transport. As a matter of fact, a Lancashire boiler can be made equal to its 160 or 200 lbs. pressure easily enough, and is then far safer than water tube boilers, and will remain safe and in good order for a period of time sufficient to end a boiler of locomotive type, and to renew a water tube boiler several times over. It thus happens that both in first cost, steam dryness, efficiency, up-keep and scrap value, the Lancashire boiler has not yet been equalled by any other type for genuine hard work, and as it can hardly be fired to the extent of damage, and so can burn coal at a greater rate per square foot than its rival, there appears no reason to suppose that, in well-designed electrical works, it will be found absent to anything like the extent that has been the case in the past. The truth is that the ability to tuck engines, boilers, dynamos, and other tackle within a very limited space is evidence of great ingenuity, but it is not therefore of necessity good engineering. Mr. Gay has chosen to use both types of boiler at the Islington station, and, we think, he has good reasons for doing so. We have heard other good engineers state that they would do the same, using the water-tube boilers to get over the peaks of the load diagram, and, perhaps, they are well advised in doing so, but to sacrifice the steadiness of the older types of boiler simply because they are slow in getting up steam, has been, we think, a great error. It was probably for reasons connected with want of steady steaming that so many early installations proved to be failures. We do not, however, agree with the *Engineer* that Mr. Gay's practice is a proof of doubt and hesitancy. To us it appears simply to show that he wished to have the power of quickly raising a small extra supply of steam with the steadiness behind it of the Lancashire boiler. It is to its large water surface that the Lancashire boiler owes its capacity of giving dry steam; but this is an advantage that will disappear if the newer superheating methods prove durable and permanently successful, for then will priming cease to be a very serious drawback. Finally, we might point out that the water-tube boiler was based on the idea that steam pressures were becoming greater than shell boilers ought to be called on to bear, but to-day the improvements in the manufacture of steel plates, of drilling and bending machines, and of the details of mechanical work on boilers, inaugurated by the late Daniel Adamson, who believed a boiler should be as carefully made as an engine, have placed the large boilers in a position of greater safety than that of the 7-feet boilers of 20 years ago. Materials and construction have in fact outstripped the rise of pressures.

A NEW FRENCH TRANS-ATLANTIC CABLE.

We (*L'Electricien*) published in one of our recent numbers the Bill relating to the establishment of a new trans-Atlantic cable.

As an appendix to this document, we now reproduce the text of the report made by Mr. Bondenoot in the name of the Budget Commission :—

Gentlemen,—The Government has laid before the Chamber a Bill, which has for its object to remedy the insufficiency of our submarine telegraph system; as also the inconveniences which result from the obligatory and almost exclusive use of foreign lines, by arranging for the establishment of direct and reliable communication between France, the United States, and the West Indies.

The Budget Commission has been unanimous in recognising that there is a serious interest to serve in throwing off the present dependent state under which submarine telegraph communication exists at the lines which unite France with her colonial possessions, or with certain countries beyond the seas with which she is in active relations.

At the present time the network of cables is almost entirely in the hands of English companies, and it appears to me useless to enlarge on the grave inconveniences which this state of affairs entails on French industries and commerce, not to mention the interests and requirements of the national defence.

At the moment of writing these lines, there is not a single telegram despatched from any part of Europe, even from France, which has not to pass through England before it can reach America.

We have laid before the Budget Commission a map showing the international telegraph lines, which indicates that all parts of the world are, as it were, caught in a net, of which London is the centre.

Not wishing to make the present report too tedious by long quotations, we give as appendices the following :—

1. A list of cables crossing the North Atlantic.
2. A recently published list of the principal submarine telegraph cables of the world.

An examination of these papers will show that a telegram despatched from any point of the globe cannot reach Europe excepting over the network of English cable; that all the extra European nations (and those of Europe also) pay tribute to England; that the entire commerce of the world is taxed for her benefit—a tax which cannot be slight, as it suffices to remunerate her for the enormous capital of more than £32,000,000, which represents the cost of this extensive system of cables.

It is a "pure grab" on the international communications of the world, of which, from this point of view, the various countries are vassals to Great Britain.

It is difficult to imagine the possibility of wresting away from England the monopoly of submarine telegraph communication, of which she is to-day in such complete possession. But one should encourage and aid any action which has for its object to get free from this monopoly, although only partially, and to endeavour to establish, side by side with the English lines, a system modest, but safe, which will furnish communications which may be described as autonomous. Being supported at first, a scheme of this kind might perhaps, in the future, develop by itself, and expand without having further need of State aid, or at least in only requiring it seldom and little.

Such an enterprise is not only of first rate utility and necessity, it is also of advantage to the Treasury, at least as much as the cable manufacturing industries which have been so wisely encouraged for the last few years. This encouragement has first of all assisted their springing into existence, and has further allowed them practical experience in establishing the French cables from Marseilles to Oran, from Marseilles to Tunis, from Australia to New Caledonia, and lately from Majunda to Mozambique.

The writer of the report then refers to the considerations just put forward in the introduction to the Bill. These considerations cannot but call for the approbation of your Commission. The principle of the Bill once admitted, we have in the first place to consider the question of expense, and to inquire whether the charges which the State is about to take on itself are warranted by the advantages which the country will derive from the execution of the project. In the second place, we have to examine in detail the clauses of the contract to assure ourselves that these are drawn up in such a way as to produce the results which we should expect from it.

As far as the financial charges which may fall upon the State are concerned, they consist in an annual subsidy, limited as to time and amount. The time fixed is a maximum of 30 years, and the amount cannot exceed £32,000, and the Government is advised by the estimate of those appointed to draw up the concession that after the first few years of working the amount will be much less; in fact, in Article 6 it is stipulated that when the receipts reach £66,000, anything beyond that two-thirds of the excess goes to the State, thus diminishing the subsidy by such amount, the other third going to the company, which will thus be interested in increasing its profits.

By means of the expenditure thus definite and limited, we procure the construction of a new cable between France and America; the maintenance and replacement of the existing cable, which was about to reach the expiry of its term, according to the original concession, which neither stipulated for maintenance or renewal; in fact, we secure a line of communication of which the need is now so much felt between the system now existing in the West Indies and the two above-mentioned trans-Atlantic cables.

If one considers the considerable interest and the various advantages, as well as the economy in the expense of sending telegrams which the State will derive from such an enterprise, not to mention the effect on French industry and commerce, one cannot fail to recognise that the demands made on the public treasury is really insignificant in comparison with the result to be obtained.

The question of the subsidy once settled, let us examine into the question of the great lines of communication. We must first of all assure ourselves against the recurrence of certain events which the past has furnished us with regrettable examples which have shown that at a given moment the whole existing French lines passed into the hands of foreigners.

For this reason, the superintendence and control by the French Government on the action of the French Cable Company ought to be exercised in a constant and assiduous manner. On this question, articles 5 and 14 appear to us to offer every desirable guarantee. Article 14 stipulates that the French Government reserves the right to organise "such control which it may judge necessary to ensure the execution of the contract," and these general terms must embrace not only the technical and financial point of view, but also all other points of view, commercial, military, international, &c. Article 5 stipulates that the company will have its board in France, and will be composed of only French directors; that the company cannot cede any of its rights without the express consent in writing of the French Government, nor shall it be able to undertake the execution of other lines which may possibly reduce the traffic of the trans-Atlantic lines provided for by the contract.

We had afterwards to consider the safeguarding of the French industrial and commercial interests, and of the preference to be accorded to them from the point of view of the works of construction, maintenance, and working of the undertaking. Article 4 provides that the new cables should be manufactured in the factories situated on French territory, laid by French employés, &c.

Finally, in granting the necessary financial assistance to the French cable company, which has known how to triumph over the hesitation and distrust unhappily so common in our country when one initiates a new industry, the opportunity arose for the Government not to tie itself down by a solitary concession, not to create a monopoly to the profit of any special company, and not to grant the concession for an excessive period.

Article 2 appears to us to sufficiently respond to this order of ideas; it assigns a term of 30 years to the concession, and it stipulates that the authorisation which it accords does not carry any exclusive right, the Government reserving to itself the right of granting any landing concessions which it may judge advisable.

These principal points established, it only remains for the Budget Commission to analyse successively each article of the Convention.

In the course of this analysis we have been led to submit

to the Government certain observations which appear to us may be made the object of modifications of detail of a nature to render the convention better still in that which concerns the advantage and guarantees which the State may and should desire.

We say at once that the Government is in accord with the views of the Commission, that it has made these views its own, and has asked the French Cable Company to do its duty.

The latter, after discussion, has consented, and a report has been signed in conformity with the remarks of the Budget Commission; this we shall see in the analysis of the several articles of the Convention.

Article 1. This article compels the company:—

1. To lay between Brest and Cape Cod (United States), within the maximum period of two years, to date from the day of approval, a new cable, absolutely direct, that is to say without intermediate landing, with a large transmitting capacity.

2. To keep in repair its existing line (Brest — Saint Pierre—Cape Cod), and in case of need to replace it, besides also maintaining, pending the duration of the contract, the branch section existing from St. Pierre to Cape Canso.

3. To have ready in working order within the same period of two years, a submarine line joining the West Indian lines belonging to the company with the trans-Atlantic cables, thus establishing a much required connection between the two great portions of their system which are at present isolated from each other.

(*To be continued.*)

ON SECONDARY BATTERIES FOR ELECTRICAL LOCOMOTION.

By DESMOND G. FITZ-GERALD.

(*Continued from page* 437.)

In designing a secondary battery—more especially for traction purposes—the most important point on which judgment is required is that of deciding upon the initial percentage (N), and the final percentage (n) of sulphuric acid in the electrolyte. If the differences between the percentages be small, the weight of electrolyte may be excessive; if it be large there is a probability either that the initial strength of the acid may be such as to produce a detrimental amount of local action, or that the final conductivity of the electrolyte may be so small as to produce a great falling off in the current. On the one hand it is desirable to work only a little above and a little below the percentage (29·6) of real H_2SO_4, which gives the maximum conductivity and the sp. g. 1·215; on the other hand it is desirable, generally, to avoid a sp. g. as high as 1·200 and an excessive bulk of electrolyte. We have further to bear in mind that below, as well as above, the density 1·300, corresponding to a percentage of 40 real acid, persulphuric acid is freely generated in charging, and that the hydric peroxide generated by its decomposition

$$[H_2S_2O_8 + 2H_2O = H_2O_2 + 2H_2SO_4]$$

may be more detrimental to the plates than the strong acid. Lastly, we have to consider that in an afluidic cell, where the circulation of the electrolyte is, to a great extent, impeded, it may be not only safe but advantageous to use acid of such strength as to be dangerously inducive of local action under ordinary conditions.

Having decided upon the values, N and n, we have next to determine, from data involving the weight of active material and the rate of discharge, what will be the effective capacity of our battery under the particular conditions of working for which it is designed; *i.e.*, the capacity corresponding to a given ratio $\frac{\text{ampere hours}}{\text{lb.}}$. What may be the capacity under lower rates of discharge? is a question which we cannot afford practically to take into account in the case of a traction accumulator worked under tolerably constant conditions. Calling Q the effective capacity, the weight (A) of true H_2SO_4 required is Q × ·008 lb. The weight (Aq) of water corresponding to the required percentage (N) of real acid will be $\frac{A\ (100 - N)}{N}$ lb.; and the total weight of acid of the required strength will be:

$$W = A + Aq + \frac{A \cdot Aq + Aq^2}{\frac{100\ A}{n} - (A + Aq)}$$ *

Let us now take a few cases in which the weights of acid adopted in practice may be compared with those calculated by means of this formula.

The late Mr. Anthony Reckenzaun was a frequent contributor to the pages of the Electrical Review, and—following upon an extended series of articles on "Electric Locomotion,"—his "Practical Notes Concerning the Construction, Use and Management of Storage Batteries" will be found distributed through several volumes of this journal, commencing with Vol. XIX. In vol. XX., p. 251 (March 18th, 1887), he writes as follows:—

"*Volume of Acid Relatively to Volume of Active Material.*—If the electrolyte is too weak, or if there is too little of it, then it becomes absorbed by the lead or exhausted at an early stage, when water only is left. The volume of the acid must bear a certain ratio to the volume of active material, and this ratio had to be ascertained by practice. Referring to p. 584, Vol. XVIII. (this, I find, should be Vol. XIX) we find that the cell (*a*), of 150 ampere hours capacity, contained 23 plates—11 positives and 12 negatives. The volume of peroxide in the positives was 36·9 cubic inches, and that of spongy lead in the negative plates 30·23 cubic inches, giving a total of 67·13 cubic inches. The displacement of the 23 plates, including their supports, was 105 cubic inches. The contents of the box occupied 280 cubic inches when the level of the liquid reached ¼-inch above the top edges of the vertically arranged plates; consequently we had 175 cubic inches left for the acid of 1,170 density. We had thus 2·6 cubic inches of acid for every cubic inch of active material, and 1·666 cubic inch of acid for every cubic inch of plate, including supporting frames and terminals. The results obtained in practice with these cells justify us in regarding the above proportions as advantageous."

What, now, was the final percentage (n) of H_2SO_4 in the electrolyte when the above cell had supplied 150 ampere hours?

From the above formula for the weight (W) of dilute sulphuric acid, a given strength (N), we derive the following equation:—

$$n = \frac{100\ A \times [W - (A + Aq)]}{A \times Aq + Aq^2 + W\ (A + Aq) - (A + Aq)^2}$$

$$A = Q \times \text{·}00805 = 150 \text{ amp. hours} \times \text{·}00805 = 1\text{·}2075 \text{ lb. of } H_2SO_4.$$

$$W = 175 \text{ cubic inches} \times \text{·}03617 \times 1\text{·}170 = 7\text{·}406 \text{ lbs.}$$

$$Aq = \frac{A \times (100 - N)}{N} = \frac{1\text{·}2075 \times 77}{23} = 4\text{·}0425 \text{ lbs.}$$

$$A \times Aq = 4\text{·}88 \text{ lbs.}$$

$$A + Aq = 5\text{·}25 \text{ „}$$

$$Aq^2 = 16\text{·}34 \text{ „}$$

$$(A + Aq)^2 = 27\text{·}56.$$

Thus

$$n = \frac{120\text{·}75 \times (7\text{·}406 - 5\text{·}25)}{4\text{·}88 + 16\text{·}34 + 7\text{·}406 \times 5\text{·}25 - 27\text{·}56} = 8\text{·}37 \text{ per cent.}$$

Acid of this percentage strength, corresponding to sp. g. 1·055, offers a resistance which is, roughly, 14 times greater than that of the acid of sp. g. 1·215. Moreover, we now know that a rapid fall of E.M.F. occurs when the proportion of H_2SO_4 has diminished to about 10 per cent. No one, I suppose, would, in these days, run down the electrolyte to this extent, though I am not quite certain on this point. At all events, Reckenzaun himself soon altered his views; for, in the issue of this journal dated June 22nd, 1888, he wrote as follows:—

"It appears that very strong and very weak acids have not only a detrimental effect upon the chemical action, but they do, at the same time, increase the resistance of the battery;

* For the derivation of this formula, see the last issue of the *Journal of the Institution of Electrical Engineers*, p. 78.

consequently it must be wise to keep the specific gravity within narrow limits, in order to obtain the best results. After numerous experiments, we have come to the conclusion that it is advantageous to use acid of such a strength that, when a cell is fully charged, the sp. g. should not exceed 1·200."

A la bonne heure! Except in the case of afluidic cells, I think that the rule here laid down is quite correct. But, taking N = 27 (which is the percentage strength of acid of sp. g. 1·200 at 15° C.), what should be the value of n? Duly taking into consideration Pickering's conductivity curve, and also Gladstone's voltage curve, I should not take a lower value than that corresponding to acid of sp. g. 1·144, which makes $n = 20$.

With these values for N and n, the corresponding values in the equation for W will be:

$$\begin{aligned} A &= 1{\cdot}2075 \text{ lb. (as before)} \\ Aq &= \frac{73 \times 1{\cdot}2075}{27} = 3{\cdot}635 \text{ lbs.} \\ A &+ Aq = 4{\cdot}842 \text{ lbs.} \\ A &\times Aq = 4{\cdot}386 \\ Aq^2 &= 13{\cdot}21 \\ (A &+ Aq)^2 = 23{\cdot}44. \end{aligned}$$

And the weight of acid of sp. g. 1·2 will be:

$$W = 4{\cdot}842 + \frac{4{\cdot}386 + 13{\cdot}21}{\frac{120{\cdot}75}{20} - 4{\cdot}842} = 12{\cdot}86 \text{ lbs.}$$

Excepting that it is much smaller in bulk, the cell we have been considering appears to correspond very closely to the E.P.S. cell T-23; the capacity of which is stated to be 145 ampere hours. The total weight of the latter cell is 66 lbs., of which 22 lbs. is electrolyte. Here the weight of acid is 9 lbs. greater than is necessary; in other words, a useless addition of 16 per cent. is made in the case of a battery which, being ostensibly designed for traction purposes, should be of the minimum weight compatible with efficiency and durability.

Let us suppose this cell, modified as might be necessary to suit the altered conditions, to be mounted on an afluidic system, *i.e.*, with a suitable absorbent to prevent the free movement of the electrolyte. In this case, as I have before observed, it is both safe and advantageous to use acid of a sp. g. as high as 1·300, giving to N the value 40. We may then *work down to the density of maximum conductivity* (1·215), so as to realise as far as possible the conditions to give a constant current with sudden fall. We thus get for n the value 29. What will be, under these conditions, the requisite weight of acid of sp. g. 1·300?

Let us take A = 1·2075 lb. as before,

We shall have:

$$\begin{aligned} Aq &= \frac{60 \times 1{\cdot}2075}{40} = 1{\cdot}81 \text{ lb.} \\ A &+ Aq = 3{\cdot}02. \\ A &\times Aq = 2{\cdot}186. \\ Aq^2 &= 3{\cdot}28. \\ (A &+ Aq)^2 = 9{\cdot}12. \end{aligned}$$

and

$$W = 3{\cdot}02 + \frac{2{\cdot}186 + 3{\cdot}28}{\frac{120{\cdot}75}{29} - 3{\cdot}02} = 7{\cdot}82 \text{ lbs.}$$

Thus we have a less weight of acid than was originally proposed to be used by Reckenzaun; and we have acid of maximum conductivity at the end of the discharge, in lieu of acid having a specific resistance 14 times greater. Although there may be something to be said on the other hand, we have here, it will be seen, a radical change in the ordinary conditions, which in itself might be sufficient to convert a failure into a success. The weight of the "afluidic" absorbent and electrolytic conductor, and the effect of impeding the circulation of the electrolyte, have to be taken into account and will be considered further on.

Let us now take the case of one of the various types of accumulator manufactured by the Chloride E. S. Syndicate, Limited, viz., their "T. B. 5." The total weight of this cell, with electrolyte, is 38 lbs., of which about 13 lbs. is electrolyte. Speaking under correction, for I have had the cell in my hands only for the purpose of mounting it as an afluidic battery, the effective capacity, at the maximum rate of discharge of 24 amperes, is 72 ampere-hours. Assuming that the initial sp. g. of the acid in the charged cell is 1·200, and that the final sp. g. in the discharged cell is 1·150, the values for N and n will be 27 and 21; and the remaining values for our equation giving the required weight of acid of the higher sp. g. will be:

$$\begin{aligned} A &= {\cdot}00805 \times 72 = {\cdot}58 \text{ lb.} \\ Aq &= \frac{73 \times {\cdot}58}{27} = 1{\cdot}57 \text{ lb.} \\ A &+ Aq = 2{\cdot}15 \text{ lb.} \\ A &\times Aq = {\cdot}91 \\ Aq^2 &= 2{\cdot}46 \\ (A &+ Aq)^2 = 4{\cdot}62 \end{aligned}$$

and

$$W = 2{\cdot}15 \times \frac{{\cdot}91 + 2{\cdot}46}{\frac{58}{21} - 2{\cdot}15} = 7{\cdot}67 \text{ lbs.}$$

The excess of acid is in this case 69 per cent.; and the battery itself is consequently 16 per cent. heavier than it need be.

We may now inquire: What weight of acid of sp. g. 1·300—as used in the afluidic system—would be required?

Here we have N = 40.

$$\begin{aligned} A &= {\cdot}00805 \times 72 = {\cdot}58 \text{ lb.} \\ Aq &= \frac{60 \times {\cdot}58}{40} = {\cdot}87 \text{ lb.} \\ A &+ Aq = 1{\cdot}45 \text{ lb.} \\ A &\times Aq = {\cdot}505 \\ Aq^2 &= {\cdot}757 \\ (A &+ Aq)^2 = 2{\cdot}10 \end{aligned}$$

The value I take for n is the percentage of acid giving the maximum conductivity, viz., 29.

Then

$$W = 1{\cdot}45 \frac{{\cdot}505 + {\cdot}757}{\frac{58}{29} - 1{\cdot}45} = 3{\cdot}74 \text{ lbs.}$$

But, in order to allow of the weight of acid being reduced to this extent—from 13 to 3·74 lbs., or 71 per cent.—some radical alterations will require to be made in the construction and arrangement of the elements of the battery. Taking the cell as actually constructed, I used, in mounting it as an afluidic battery, 5·5 lbs. of absorbent and 6·9 lbs. of acid of sp. g. 1·300; the total weight of which is not very far from that of the original electrolyte of sp. g. 1·200; but when the weight of 6·9 lbs. of acid is reduced to 3·74 lbs., the weight of absorbent will be reduced in the same ratio, viz., from 5·5 lbs. to $5{\cdot}5 \times \frac{3{\cdot}74}{6{\cdot}9} = 3$ lbs., so that the total weight in substitution for the 13 lbs. of fluid electrolyte would be only 6·74 lbs., or not much more than half the original weight, and the economy effected in the weight of the accumulator by the substitution of the afluidic for the present system would be about 16½ *per cent.*, or nearly 1⅔rds cwt. per ton.

A good battery of its kind—one that has been used to a large extent abroad, for traction and other purposes, and one that is likely to be used in this country, is the Tudor accumulator. I have been unable to obtain any recent data in regard to this cell, but, some years ago, Prof. Kohlrausch tested it very carefully, and his report supplies data from which we can calculate the value n as actually obtained in the tests, and also the weight of acid and of absorbent required to mount the cell as an afluidic battery.

Thus we have:—

$$\begin{aligned} &\text{Capacity } (Q) = 46{\cdot}88 \text{ amp. hours (current being 6·5 amps.)} \\ A &= Q \times {\cdot}00805 = {\cdot}377 \text{ lb.} \\ N &= 20 \text{ (sp. g. being 1·147)} \\ Aq &= \frac{(100 - N)\,A}{N} = 1{\cdot}51 \text{ lb.} \\ W &= 8{\cdot}6 \text{ lbs. (of acid of sp. g. 1·147)} \\ A &+ Aq = 1{\cdot}88. \\ A &\times Aq = {\cdot}569. \\ Aq^2 &= 2{\cdot}27. \\ (A &+ Aq)^2 = 3{\cdot}53. \end{aligned}$$

and

$$n = \frac{37{\cdot}7 \times 6{\cdot}72}{{\cdot}569 + 2{\cdot}27 + 14{\cdot}17 - 3{\cdot}23} = 1{\cdot}88.$$

I need not point out that to reduce the electrolyte to this percentage of real acid is very bad practice.

On the afluidic system we have :—

$$W = \cdot 942 + \frac{\cdot 212 + \cdot 319}{\frac{87 \cdot 7}{29} - \cdot 942} = 2 \cdot 42 \text{ lbs.}$$

According to data derived from certain cells I have mounted on my own afluidic system, the weight of acid *plus* absorbent will be about $2 \cdot 42 \times 1 \cdot 716 = 4 \cdot 15$ lbs.

Whether it be convenient or practicable to construct secondary batteries, in which the space occupied by the plates bears so high a ratio to that occupied by the electrolyte, must for the present be an open question.

(*To be continued.*)

CONCENTRIC CABLES.

A letter that appears this week in our "Correspondence" column draws attention to a point in connection with concentric cables that does not seem to be as well known as we previously imagined. Recently, in conversation with one of the engineers of a well-known firm, we learnt with some surprise that he thought that a perfectly insulated concentric cable, connected to an equally well insulated alternator, had one of its conductors as much above the potential of the earth as the other was below. That is to say, that if the potential difference between the inner and outer of the cable be, say, 2,000 volts, that the inner would be 1,000 volts above the earth potential, and the outer 1,000 volts below this. It may therefore be worth while to devote a few lines to a simple explanation of the facts.

Our correspondent asks two questions. The first is :—

If the outer of a concentric cable were earthed (the difference between the inner and outer conductors being 2,000 volts alternating virtual, maintained, say, by an alternator), and anyone touched a part of that circuit, would he get 2,000 volts to earth?

The second question is :—

If the circuit were not earthed, would he get only 1,000 volts to earth?

In discussing this question, it must be borne in mind that the conditions are not those of ordinary electrostatic experiments. There the bodies experimented upon are usually insulated from one another. Here the two conductors in the cable are not, but are connected together through a low resistance conductor, in which there is maintained a gradient of electrical pressure inductively. The two conductors have, therefore, impressed upon them a potential difference of 2,000 volts, and this is the pressure that must exist between them.

In the first case let us assume, for the sake of argument, that two single well insulated cables are connected, one to each terminal of the alternator. These cables will have equal electrostatic capacities, and will form a condenser system with each other and with the earth. If they are far removed from each other, the latter is more important than the former. The result will be that whereas only 1,000 volts potential difference will exist between each of the cables and the earth, the pressure between them is 2,000 volts. Anyone touching one of the cables will be subjected to a condenser current with an initial pressure of 1,000 volts, and this even if the insulation throughout be practically perfect.

Suppose that a leak to earth comes on one of the cables, then the equilibrium of the system is momentarily disturbed, and the pressures will readjust themselves. The leaky cable will sink to earth potential, and the other will be raised to 2,000 volts above the pressure of the earth. It is evident that this imposes twice the dielectric strain on the insulating covering of the good cable that it had to bear previously.

Coming now to concentric cables, we have an entirely new set of conditions. The outer of a concentric cable entirely surrounds the inner, and cuts off the inductive action of the inner upon all external bodies, including the earth. The capacity of the outer is very much greater than that of the inner, and therefore under similar conditions to those above postulated, the outer conductor is normally at earth potential and the inner at the full impressed pressure above it. Anyone touching the outer would not disturb the system in any way (leaving out of account certain subsidiary capacity effects, and confining ourselves to the main question), but anyone touching the bared end of the inner would find that it was at 2,000 volts difference from the earth.

We have, however, under such conditions, insisted upon the perfect insulation of both poles, of the alternator and the cable. A fault coming on in the armature winding of the alternator, or in a transformer (if such a device were being supplied by the concentric cable) would at once upset the natural state of things, and the outer would no longer be at earth potential. To maintain, under all conditions, a desirable combination of circumstances it is now customary to earth the outers of all concentric cables at the station switchboard, and then we make it certain that on the appearance of any such fault as that indicated due notice will be given on the switchboard instruments.

The Board of Trade permit this station earthing because (*a*) it does not introduce an artificial or forced equilibrium of the system, but only fixes, as it were, the natural state of things; and (*b*) it maintains the outer conductor of concentric cables at earth potential, and makes it safe for workmen to handle them with the current on. Long before this safeguard was adopted, engineers on the Continent were troubled with disruptive discharges from the outer of concentric cables to earth, and to prevent this it was found to be necessary to make the outer insulation much thicker than that between the conductors. Mr. Ferranti, at Deptford, was one of the first to advocate earthing, and he showed the Board of Trade officials experiments in which some of his assistants drove firemen's axes into his tubular mains when these were coupled up to a 10,000-volt alternator.

The outer of a concentric cable is insulated to prevent the return current returning to the station by earth, and to avoid telephonic disturbance. It is on record that once the Deptford mains happened to find an earth on the outer conductor in London. The result was that so long as the second earth remained on, the telephone system of the Metropolis gave evidence of the unusual and undesirable state of affairs.

In the Mavor and Coulson concentric wiring system the outer is uninsulated. There is then a possibility of electrolytic trouble owing to the return current leaving the outer conductor and going to earth, since the C R pressure drop on the outer must result in a difference of pressure between the two ends of a main. Mr. T. B. Murray has proposed to minimise the evil by making nearly all the drop take place on the inner conductor, and proportion the outer, so that by adding the copper saved to it very little drop will occur on the earthed pole.*

Mr. Geipel is of opinion that the insulation of the outer of all concentric low tension distributing mains might be dispensed with. It might be necessary to slightly insulate the outers of the feeders to obviate telephonic interference and electrolysis, but the difference of potential between any parts of a distributing network is so small, that he considers there appears little necessity of insulation, especially as the outer is, even when insulated, invariably at earth potential.†

The question which we have briefly discussed above has been dealt with by Major Cardew,‡ Dr. Fleming,§ and Mr. Preece,‖ in papers read some years ago before the Institution of Electrical Engineers.

In the discussions on these papers, Dr. Fleming said that experiments confirmed the fact that the exterior conductor of concentric cables always assumed the potential of the earth when the two conductors are insulated and connected to an insulated dynamo, and this he took to be one of the recommendations for using such cables with alternating currents. Mr. Swinburne also made some remarks on the earth currents on the Deptford cables, and Mr. Preece stated

* *Jour. Inst. Elec. Eng.*, p. 622, Vol. xxiv.

† *Jour. Inst. Elec. Eng*, p. 32, Vol. xxv.

‡ "Electrical Shocks from High Pressure Conductors." *Jour. Inst. Elec. Eng.*, p. 322, Vol. xx.

§ "Effects of Alternating Current Flow." *Ibid.*, p. 401, Vol. xx.

‖ "Some Points connected with Mains for Electric Lighting." *Ibid.*, p. 420, Vol. xx.

that earthed concentric mains eliminated telephonic disturbances, but that in Rome disturbances were experienced when leakages came on the secondary network.

Mr. Stuart Russell has pointed out * that with two separate mains laid underground, so that their outer coverings are earthed, the danger of receiving a shock is very remote, except when some part of the conductor itself is handled; and this same danger occurs on a circuit in which the cables are concentric, unless the concentric principle is carried right through to all connections to transformers and switches; that is, unless the inner conductor, and all apparatus to which it is connected, are entirely enclosed at all points of the circuit within the outer conductor. When this is the case, and the outer conductor is earthed, it is difficult to imagine any arrangement that could give greater safety; but it is very difficult (and rather unusual) to carry out the concentric system so completely, and, therefore, the degree of safety obtained by the use of concentric cables is not so great as theory would indicate.

COLONIAL CABLE COMMUNICATION AND THE PROJECTED PACIFIC CABLE.

By A CABLE EXPERT.

(Concluded from page 435.)

Assuming that the cable is to be a Government undertaking, participated in by Great Britain, Canada, and Australasia, and that the cost of the cable and its maintenance for three years will be £1,800,000, the estimate for 10 years' exploitation would work out as follows:—

For the first three years the fixed charges would be:—

Interest on £1,800,000 at 2½ per cent.	£45,000
Working expenses, staff, management, &c.	30,000
Total fixed annual charges	£75,000

With regard to the revenue, it is calculated that half of the traffic now passing over the existing cables would be diverted to the new route. Assuming that the cable terminated its first full year of exploitation in 1899, the gross earnings would be, at the 2s. tariff, £110,000. For 1900 they would be £126,500, and for 1901, £143,000. If from these estimated yearly earnings we deduct in each case the fixed charges for interest and working expenses of £75,000, we should have a surplus in 1899 of £35,000, in 1900 of £51,500, in 1901 of £68,000, making a total surplus of £154,500 for the first three years' exploitation. During the whole of this period the cable would be kept in repair at the expense of the contractors. After the third year the cost of cable repairs would become a charge against surplus earnings, which would, as demonstrated hereafter, be ample for the purpose. The following table covers the remaining seven years of the first ten years' exploitation. The cost of repairs and maintenance, usually estimated at £6 per mile, would amount to £43,000 per annum. But for this service the estimate allows £50,000, which, added to interest and working expenses, increases the charge against revenue to £125,000 per annum:—

	Gross earnings.	Charges.	Surplus.
	£	£	£
Surplus for first three years	...	...	154,500
1902	159,500	125,000	34,500
1903	176,000	125,000	51,000
1904	192,500	125,000	67,500
1905	209,000	125,000	84,000
1906	225,500	125,000	100,500
1907	242,000	125,000	117,000
1908	258,500	125,000	133,500
Total surplus in 10 years			£742,500

The estimates show an increasing surplus every year on the assumption that the traffic would increase yearly by 15 per cent. This assumption is fully warranted by the data. The low interest, another important factor in the calculations, pre-supposes the co-operation of the Imperial Government with the Governments of Canada and Australasia in this Imperial project. Although there is no probability of loss or insufficiency of revenue to meet all charges, it is intended that the precise responsibility attached to the several Governments shall be clearly defined. This will probably be done at the forthcoming conference, when the sum payable by each Government will be determined. Nevertheless, it is probable that by a mutual effort Great Britain, Canada and Australasia can establish the Pacific cable without cost to their taxpayers. The Canadian Intercolonial Railway was established by the guaranteee of the British Government, which guarantee involved no ulterior liability whatever. It will be noticed that no account is taken of the Canadian-Australian traffic, which will undoubtedly spring up when cheap cabling is inaugurated. The reduction from 4s. 9d. to 3s. per word will, within the first year of working the Pacific cable, effect a gross saving on Anglo-Australian traffic of £190,000. This saving will be repeated annually, and will continually be augmented by the growth of business, even supposing the rates should not be lowered. This cable would practically extinguish all subsidies now paid, render guarantees unnecessary, and establish permanent low rates for ocean telegraphy over vast and ever-growing areas of British commerce and industry. Indeed, it is confidently expected that it would ultimately yield large surplus earnings which would serve to reduce the tariffs. Such reductions, effected without any appreciable extra cost for working expenses, would inevitably lead to an expansion of business. Thus the public would benefit to an extent that would be impossible if the cable were owned or controlled by an ordinary commercial corporation.

With regard to the exploitation of the cable there are two methods available. (1) Through the agency of a subsidised or guaranteed company. (2) Directly by Government as a public work. The former method would undoubtedly give least initial trouble to the Governments concerned, who could offer liberal subsidies to have the cable laid, owned and worked by a private company. But it is considered by many colonial statesmen and experts who have carefully studied the question that the latter method would be far more advantageous. The interests of a company and those of the general public are seldom identical. A company will endeavour to extract from the public as much profit as possible by the creation of a monopoly. A Government enterprise can be managed with a view to public convenience, providing an efficient service at a reasonable tariff. Should a large subsidy be granted, its direct effect would be to confirm and perpetuate the cable monopoly with its prohibitive tariffs and other drawbacks. Whether the work be entrusted to the existing companies or to a new and distinct corporation, the ultimate result must be the same. It would be practically impossible to prevent the rival companies from combining, openly or secretly, to the public detriment. It has been objected that the British Government should not enter into competition with a private company or undertake the ownership of ocean cables. Lord Jersey, who represented Great Britain at the Ottawa Conference, has met the first of these objections. In his official report on that Conference he says:—"Whilst admitting and admiring the enterprise of the existing company, it cannot be conceded that it entitles the company to the cable monopoly of Australasia. The new route is not proposed from mere motives of competition, in which case Her Majesty's Government would probably decline to take part, but from the conviction that commercial and Imperial interests demand its construction." As to the second objection, it is only necessary to recall the fact that, as a measure of public utility, certain Channel cables were jointly purchased by the Governments concerned, despite the opposition of the companies owning them. Surely this policy of co-operation, adopted in conjunction with foreign Governments, can be safely extended to our own colonies? Thus the consensus of opinion is distinctly favourable to a Government enterprise. This was so generally understood, that no contractors troubled to submit tenders for establishing the cable through the medium of a public company.

The question now arises, How can the matter be arranged

* "Electric Light Cables," p. 137.

so as to produce the best results in a form acceptable to the high contracting parties? Early in May a colonial cable conference is to meet in London, and if it be, as it is expected, under the presidency of Mr. Chamberlain, a policy of active participation by the British Government may be looked for in this truly Imperial and self-supporting work. There will be six delegates: two representing the Imperial Government, probably Mr. W. Hepworth Mercer, and a high official of the Government Telegraph Department; two representing Canada, Hon. Mackenzie Bowell and Mr. Sandford Fleming; and two representing United Australasia, Sir Saul Samuel and Hon. Duncan Gillies. At this conference a definite scheme of action will doubtless be elaborated.

Assuming that the principle of co-operation and State ownership be assented to, as it probably will be, the capital may be raised by one of these three modes:—1. The whole amount may be raised by the Canadian, Australian, and New Zealand Governments, and the interests in each case guaranteed by the Imperial Government, the relative liability to be borne by the Imperial, Canadian, and Australasian Governments, to be apportioned by mutual agreement. 2. The whole capital may be raised by the Imperial Government, the payment of a sum equal to the interest on such portion of the capital as may be agreed upon to be guaranteed by Canada and the Australasian colonies, in proportions to be determined. 3. The capital may be raised on securities issued through the medium of an Imperial Colonial Cable Commission, a joint guarantee for the payment of interest to be given by the Imperial, Canadian, and Australasian colonies. By any one of these modes the capital may be obtained at the very lowest rate of interest. This interest would be a first charge on the revenue. But as it is expedient to provide for every contingency, the conference will be called upon to make due provision for a possible deficit. The proportions in which any such possible deficit would be paid will naturally be a matter for mutual agreement, but it is generally thought that the liability will be divided equally between the Imperial Government, Canada, and the Australasian colonies, each contributing a third. Speaking on this point, Sir Charles Tupper recently said:—"I do not hesitate to say that, in my judgment, Canada and Australasia should demand in the strongest manner from the Imperial Government a contribution of at least one-third of the capital for interest that may be required." As several distinct Governments will be concerned in the project, it may be advisable, in order to meet the difficulty of joint ownership, to create an organisation in which the administration would be centralised, an Imperial Colonial Cable Commission or Trust, established by authority of the several parliaments. It might consist of three persons, representing the Imperial, the Canadian, and the Australasian Governments respectively, with authority determined by statutes to obtain capital and to assume responsibility for establishing the work and carrying it on when completed.

This question is being watched with great interest even by the Cape Ministers, who attach the utmost importance to the project by which the Cape would obtain an alternative, all-British communication with the mother country, *via* Canada and Australia. The completion of the Pacific cable to Australia would doubtless be followed by its extension to Natal, *via* St. Paul's Island. This extension has become indispensable, owing to the continual failures, especially during the recent crisis in the Transvaal, of the cable routes between England and the Cape, *via* the East and West Coasts of Africa. According to Sir Henry de Villiers, who represented the Cape at the Ottawa Conference, there is another reason for this extension. Says he: "Our hope is that the laying of the Pacific cable may result in the laying of another cable from Australia to the Cape. Such a cable would be useful, not only for the defence of the Empire, but it would also have the practical effect of reducing the exhorbitant tariffs at present charged for telegrams from the Cape to Great Britain." It is said that the question of a duplication of the present lines, or the laying of another cable, *via* St. Helena and Ascension, has been under discussion. But whether the duplication or the new cable be adopted, no more unsatisfactory method of insuring constant communication with the Cape could be imagined, because between England and Sierra Leone, either of these lines would be exposed to danger by landing on foreign territory, or by lying in waters adjacent to foreign shores. This is a point of capital importance, for it is generally considered that cables of strategic importance to Great Britain should, if possible, only pass through countries where the British have paramount control.

There is in the chain of our Imperial communications yet another very serious break, caused by the absence of direct cable connection with the British West Indies, *via* Bermuda. As far back as 1882, a Royal Commission strongly recommended the execution of this project. The various West Indian Governments, the naval and military commanders, and the entire commercial community, have made persistent appeals for the establishment of this Bermuda-Jamaica cable, which would remove the serious drawbacks, and even dangers, resulting from the devious route followed by the existing lines. The French, Spanish, Danish and American Governments are all in a position to control, and even suspend, telegraphic communication between Great Britain and her West Indian islands. Moreover, the prohibitive tariffs charged, not only prevent their proper commercial expansion, but they have assisted, with other causes, to force the bulk of the trade into foreign markets, thus adding materially to the onerous burdens which have long rendered the struggle for existence in those islands extremely severe. The Colonies have offered £2,000 per annum and a grant for this cable, and they are now waiting for the Imperial Government to complete the subsidy. They confidently hope that the time has come to abandon that policy of indifference towards the Colonies which has discouraged them, and proved a barrier to their progress. They go further than this, and ask whether or not the paramount duty of their protection, which devolves on the Imperial Government, is to be efficiently performed. And they have just grounds for complaint. During the recent crisis the West Indian islands were left at the mercy of any possibly hostile war vessels. The Cuban landlines were cut just when the North American squadron was detained at Bermuda, the terminus of British controlled telegraphic communication in the North Atlantic. The most urgent call for assistance could not have reached the Admiral under six days. It is obvious that the colonists had grave reasons for the surprise they openly expressed at being thus left in this unprotected position. It was intensified by the fact that unlike Canada, Australia, and other important colonies, these islands are too poor to organise any system of defence which could render them independent in time of need, and save them from entire destruction by any adjacent hostile state. The need of this direct cable communication is admitted to be real and pressing. The Imperial Government can now, at a trifling cost, strengthen the British position in the West Indian Islands, quicken their commercial expansion, and establish between them, Canada, and the mother country a material bond of union which cannot but produce the happiest results. The colonists, impatient for some definite action, and disappointed at the apparent indifference hitherto displayed towards a project so vital to their interests are eagerly looking to Mr. Secretary Chamberlain for a prompt and generous recognition of claims which have been so long neglected.

Such are the main points of this question of Colonial cable communication. The projectors of the Pacific system admit that the mere laying of a cable between two opposite shores of an ocean has in our time become a comparatively commonplace affair. But they claim that this project to connect Great Britain with Canada, Australasia, the Cape, and the West Indies, by an all British system which will be self-supporting, is one of more than ordinary significance. They anticipate that this comprehensive scheme will greatly strengthen the commercial position of the regions affected, and constitute a common bond between the mother country and colonies, now widely separated. The co-operation of Great Britain and her principal colonies in establishing this telegraphic connection, will present itself to the world as an ideal "co-partnership" unparalleled in history. But immediate action is imperative. Should the Colonial delegates separate without having definitely arranged for the execution of this work, either the French company or some powerful American organisation, perhaps the two in unison, will probably promptly monopolise the telegraphic control of the Pacific Ocean and the West Indies. This would constitute a national calamity, destined to produce disastrous effects on generations of British speaking people yet unborn.

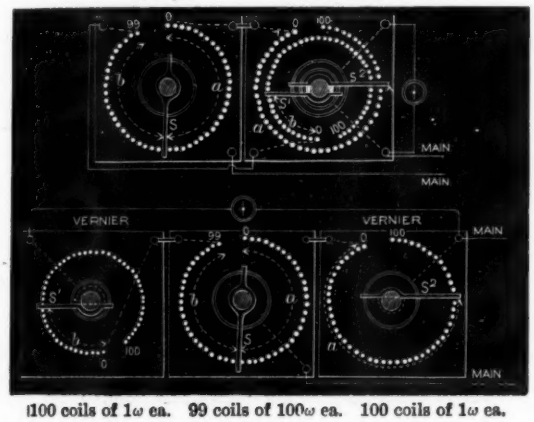
"UNIVERSAL SHUNT."

A convenient form of *adjustable* "universal shunt" has been devised by Mr J. Rymer-Jones, chief electrician of the Silvertown submarine department; this shunt has a multiplying power of any value from 1 to 10,000, while, if not required for a shunt, it can be used for all such tests as are based on the *fall of potential* principle for which the Thomson and Varley *slides* are applicable. The latter cannot, however, be used as a "universal shunt," and it is on that account that Mr. Rymer-Jones has found it necessary to modify their construction.

In a paper read before the Institution of Electrical Engineers (March 29th, 1894), "A Universal Shunt for Galvanometers," by Prof. Ayrton and Mr. Mather, is described and illustrated. This shunt obviates the inaccuracy of an *ordinarily* constructed shunt, when used with a ballistic galvanometer to compare capacities by *discharge* test, whenever unequal shunts are employed. It was pointed out by Mr. Latimer Clark some years ago that the formula $\left[\frac{G+S}{S}\right]$ giving the multiplying power of the shunt for *steady* currents, does not apply to *throws* or *momentary* currents, and it was with this primary object that Prof. Ayrton and Mr. Mather devised their "universal shunt." This not only effectually meets the difficulty, but it has the further important advantage of being applicable to all galvanometers of any type or resistance, which latter value need not be known. It is, moreover, more accurate, so that its general adoption is only a matter of time.

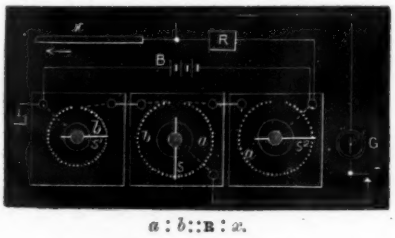
Fig. 1.

Slide, A. Vernier slide, B.



100 coils of 1ω ea. 99 coils of 100ω ea. 100 coils of 1ω ea.

Fig. 2.



$$a : b :: R : x.$$

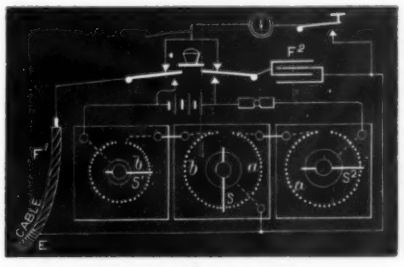
$$a : 10{,}000 - a :: R : x.$$

$$x = R\left(\frac{10{,}000}{a} - 1\right).$$

Fig. 3.

When measuring capacity by a *discharge* test, or resistances by *direct deflection*, *i.e.*, with a *continuous* current, it is desirable that the same scale reading should be reproduced as closely as possible when comparison is made in either case with the respective standards, and this becomes essential when the scale readings, from any cause, are not proportional. Again, when measuring the dielectric resistance of a cable, it is a great convenience in practice to be able to move the shunt sliding contact around the scale *gradually* from zero—the position when the galvanometer is on short circuit—and thereby to increase the shunt resistance step by step, following with the eye the spot of light moving slowly up the scale, until it reaches that point which will give best scope for a good *electrification fall*. In the case of a long cable, and especially when the temperature is low, and the *fall* consequently very rapid, the first minute reading is sometimes lost, or a deflection too small has to serve the purpose, owing to previous uncertainty as to the best value for the shunt; and when plugs are used, or a marked change has to be made from (say) the $\frac{1}{100}$th to $\frac{1}{10}$th shunt, or from $\frac{1}{10}$ to ∞ during the short interval of time available, the change may be too great to allow the deflection to settle down in time for the first minute reading. With the *slide* form of shunt there is no occasion to determine beforehand the approximate value of the shunt required for an insulation test.

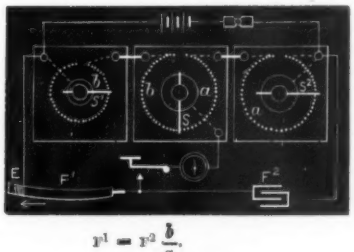
Fig. 1 shows the *slides*, as actually constructed for use, joined up as a "universal shunt"; while, for greater clearness in following the connections, fig. 2 shows the *Vernier slides* with the two circular rows of resistances, separate and distinct. Like the Thomson and Varley *slides*, they consist of two parts, with the difference that instead of having two sliding contact arms for the slides A, and one arm for the Vernier slides B, the reverse is the case with the *slides* in question. It will be seen that the *Vernier* slides B have two distinct and concentric circles of contact studs, each circle having 100 bobbins of one unit resistance. These two series of unit coils form extensions respectively to the two extremities of the 99 bobbins, of 100 units each, which form the slide resistances shown on the left hand of fig. 1, the left extremity of the latter (marked 99) being connected with the zero end of the inner circle of Vernier contacts, and the right extremity, marked O, to the similarly marked end of the outer circle of Vernier contacts. The sliding arms, S^1 and S^2, which make contact respectively with the inner and outer circle of studs, are moved around by the same handle, the unit coils being so arranged that while one arm, moving towards 100, increases the resistance in circuit on one side of slides A, the other arm moves towards zero, and reduces the resistance on the other side of A by a precisely equal amount. In other words, when one arm is at 100 of one circle of the Vernier contacts, the other arm touches the *zero* stud of the other circle. Arm S^2 moves over its own (outer) circle of contacts only, and does not touch the inner circle. There is therefore between the two arms of the *Vernier slides* always a total resistance of 10,000 units, irrespective of the position in which these arms may be.



$$P^1 = P^2 \frac{a}{b}.$$

$$P^1 = P^2 \frac{a}{10{,}000 - a}.$$

Fig. 4.



$$P^1 = P^2 \frac{b}{a}.$$

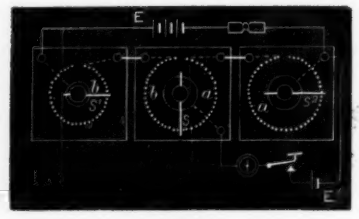
$$P^1 = P^2 \left(\frac{10{,}000}{a} - 1\right).$$

Fig. 5.

D

When connected up as a "universal shunt" (figs. 1 and 2) this resistance of 10,000 units remains unchanged between the galvanometer terminals, while the *shunt* resistance between arms s and s^2 may be varied at will from 0 to 10,000 units.

The contact arms, s and s^2, only are marked with a line thus ⟍——, as it is the positions of these two indices which denote the value of *a* when a measurement has been completed. When used as a *shunt*, *a* is the only reading required. For "bridge" and "capacity" tests, the value of *b* is also required, but this is obtained, as in the Thomson and Varley slides, by subtracting *a* from 10,000. Supposing the slide reading, *a*, be 5,237; the first two figures (52) will be read at s, and the last two figures (37) at the marked Vernier index, s^2. By means of Barlow's or other *table of reciprocals*, the multiplying power for any readings of s and s^2 may be obtained without calculation. Thus:—Taking the full current passing through the galvanometer when shunted by the whole 10,000 units as equal to 1, the slide value, *a*,



$$E = \frac{10{,}000}{a} E^1.$$

Fig. 6.

for any other shunt divided by 10,000 gives the fractional value in decimals of the current producing the deflection observed. This, in the above example, is 0·5237—the reciprocal of which gives the multiplying power of the shunt, viz., 1·909.

Examples.

s Hundreds.	s^2 Units.	Full slide reading $s + s^2$ (*a*)	Current through galvanometer.	Reciprocal or multiplying power of shunt.
0	1	1	$\frac{1}{10000} = 0.0001$	10,000
0	10	10	$\frac{10}{10000} = 0.001$	1,000
0	100	100	$\frac{100}{10000} = 0.01$	100
1	0			
10	0	1,000	$\frac{1000}{10000} = 0.1$	10
99	100	10,000	$\frac{10000}{10000} = 1.0$	1
52	37	5,237	$\frac{5237}{10000} = 1.909$	1·909

Fig. 3 shows the connections for a bridge test; Figs. 4 and 5 for Thomson's and Gott's capacity tests respectively, while fig. 6 is joined up as a potentiometer for comparing E.M.Fs.

STORAGE BATTERY TRACTION AT BIRMINGHAM.

The Birmingham Central Tramways Company have, as all the world knows, a double track tramway extending for a distance of about three miles to Bournbrook, on which motive power is supplied to the cars by electric accumulators. It is a pleasant route, for the most part through streets bordered by attractive residences, and the tram service is quite in harmony with the district. The cars are comfortable, the permanent way is in good condition, and the cars move smoothly and rapidly. The residents along the route, says the *Railway World*, express perfect satisfaction with the arrangement, and, in fact, there is only one criticism to be made on the line—it does not pay. Of course, if the patrons of the line were all shareholders in the company, this consideration might mitigate the satisfaction they no doubt experience in travelling by the most expensive tramway in the United Kingdom. But any anxiety that they may feel is probably stifled by the reflection that "the company pays for it;" and so the unfortunate company does, to the amount of about £3,000 net loss per annum. Now and then the company gently attempts to rid itself of the incubus, and tentatively suggests the substitution of the anathematised overhead wire, but a storm of indignation sweeps down Bristol Road, and in its wake the electric accumulator car meekly follows as before. But the last proposal to abolish the accumulator has put the local authorities on their guard, and when the Tramways Company recently made the usual application to the King's Norton Rural District Council for the yearly license to run cars by electricity along that part of Bristol Road within the jurisdiction of the Council, the consent was given, but only with the express proviso that the company should make no alteration in their present method of working the cars. So we may take it that there is to be no overhead wire in Bristol Road, at least, for a long time to come. And now what is to be done with the line? Is it necessary to continue a loss at the rate of 4·75d. per car mile? Have the tramways company as yet conclusively proved the claims of manufacturers of electric accumulators to be nothing more than "representations made in the course of trade?" And if there are makers of accumulators with a grain of confidence in their batteries, why do they not make it their business to offer the tramways company such terms that the company will be glad to grant them the opportunity to work their line. If a really advantageous *bona fide* offer were made, and the directors of the company showed reluctance to accept it, an intimation of the circumstance to the local press, which has not unfrequently done good service for the shareholders, would, perhaps, clear the way. But there is no doubt that the directors would be glad to find a way out of their difficulties; and the advocates of accumulators will have only themselves or their accumulators to blame if they do not demonstrate that their claims are well founded. Possibly, however, the day of the overhead wire on Bristol Road is nearer than at present seems likely. The company have been given permission to construct an overhead trolley line on the Nechells route, and they will thus have an opportunity to show that with the best and most recent devices for minimising the annoyance of the overhead work the trolley is, after all, quite harmless even to the amenities of Bristol Road.

EFFECT OF TEMPERATURE UPON STRENGTH OF WROUGHT IRON AND STEEL.

At a recent meeting of the American Society of Mechanical Engineers, Mr. R. C. Carpenter described a series of tests conducted in the testing laboratory of Sibley College, with a view to determine the effect of temperature upon the strength of wrought iron and steel. The tests were made upon a 100 ton Emery testing machine, which was built by William Sellers & Co., for the Columbian Exposition.

To enable the test piece to be maintained at the desired temperature for a considerable length of time, it was enclosed, says the *Scientific American*, in a solid block of cast iron, made in two halves, longitudinally, and clamped upon the specimen. A mercurial thermometer, the upper part of which was filled with nitrogen to prevent vaporisation of the mercury at high temperatures, was placed in direct contact with the test specimen within the cast iron box, which was heated from below by four Bunsen burners. This method of heating proved satisfactory, and gave very uniform results. The best specimens were turned down to a diameter of one half inch for a length of 8·8 inches. 30 specimens of wrought iron and 25 of steel were tested, the temperatures varying from 22° to 825° F.

Results.—The general results of the test show that all the curves have a point of contraflexure at about 70° F., and another at a temperature not far from 500°. The maximum strength is found at temperatures of 400° to 550° F. At temperatures higher than this, all the materials show a rapidly decreasing strength. The variation in strength with change of temperature is marked; thus, for instance, with wrought iron, if we represent the strength at temperature of 75° F. as 100, that at from 22° to 25° is 103 to 104, at 500° F. is 126, while at 825 it would be repre-

sented by 80·7, which is 63 per cent. of the maximum strength; beyond this point the strength steadily decreases.

The curve for tool steel has the same general form, the temperature of maximum strength being, however, about 400°. That for machinery steel is similar, but no experiments were made at low temperatures and no critical point was observed.

The elongation in 8 inches of length for the tool steel and wrought iron is shown in curves of the same general form, which agree in showing smallest elongation when at a temperature about equal to the boiling point of water

Tests of Wrought Iron Specimens.

Temperature in degrees Fahrenheit.	Tensile strength in lbs. per square inch.
23	50,500
82	48,820
250	54,010
320	57,240
475	62,610
625	54,450
825	39,330

Tests of Machinery Steel Specimens.

Temperature in degrees Fahrenheit.	Tensile strength in lbs. per square inch.
73	63,650
300	68,680
525	116,370
575	105,660
680	58,120
800	55,460

Test of Tool Steel Specimens.

Temperature in degrees Fahrenheit.	Tensile strength in lbs. per square inch.
28	107,990
75	140,080
160	109,650
230	132,310
425	145,200
600	120,170
825	103,740

The author of the paper states that he is largely indebted for the above data to a thesis investigation of O. R. Wilson and R. L. Gordon, of Sibley College.

WIRING RULES.

Fire insurance offices and supply companies have done much to teach contractors how wiring should be done, what must be avoided, and what may, under special circumstances, be permitted, and it is the boast of Mr. Heaphy that no loss has ever been incurred by his office where the Phœnix rules have been complied with. Mr. Heaphy is nothing if not conservative, and we could hardly expect him to view with equanimity several of the more recent proposals towards the development of the supply company's branch of the electrical industry.

Two new sets of rules have just been issued that are well worthy of attention. One is the 1896 edition of the "Installation Rules of the Liverpool and London and Globe Insurance Company," and the other the "St. Pancras Vestry Rules for 220-Volt Wiring."

Both of these show that the compilers possessed a clear practical knowledge of the requirements to be met, and of the means too often adopted in jerry-wiring to shirk the burden that falls upon those who really do try to erect everything in a proper manner. Some contractors may object to these rules as unnecessarily severe. We can only say that the stipulations, with one or two exceptions, are none too stringent, and they but express in words the manner in which first class work would be done by a responsible firm.

We will take the insurance rules first. A very good indication of the spirit in which they have been framed is afforded by the second clause of the introduction, which expressly states that new commercial applications of the electric current, or applications newly used on a commercial scale, which may necessitate the special installation of plant and accessories upon lines differing from the requirements of the company will be dealt with in a friendly and liberal spirit, but departures from the specified practice can only be allowed by special permission. The rules are intended to apply to cases where the current is used at a pressure not exceeding 250 volts, and it is pointed out that in some cases the Board of Trade requirements are more stringent than the rules. In other cases where the Board of Trade regulations are not so complete, the cause is to be attributed to the lesser degree of safety considered as being sufficient for the safety of the *public*; and the safety of the *insured* has to be more particularly looked after from the point of the *insurer*.

The principal sources of danger are held to be:—1. Inferior materials and workmanship, particularly in joints, fittings, and connections. 2. Conductors of inadequate size and conductivity. 3. Perishable and inferior jointing material. 4. Dust, dirt, and moisture. 5. Undue heating. 6. Neglect of frequent testing and inspection. We are glad to see that the danger of allowing incandescent lamps to rest against light combustible material is given a prominent place, and that the paper labels frequently attached to lamps are condemned. Shop window lighting is wired in general in a most rough and unsafe fashion. The shell reflector lamps, so popular with certain kinds of window dressing, are often wired with pure rubber flexible, and the twin cord is stapled to the window frame. Here are the warnings to be noted: Lamps should not be capable of attachment by window dressers in hazardous positions; twin conductors should only be used for pendant fittings, or to connect portable fittings, and should always be in sight; they should not be run inside casing or along walls or ceilings; it is highly necessary to protect twin conductors from injury with the greatest care (as should they be improperly treated they form one of the most dangerous points in an installation); to use only properly insulating supports; to have suitable insulating bushings of the holes in metal fittings where twin wire enters, and to maintain them in an efficient state of repair.

Properly insulated conductors may be run in one of several ways indicated. These are:—

1. In fireproof and damp-proof tubes, in which positive and negative conductors may be bunched.
2. In wood casings, where the conductors must be rigidly held and kept separate.
3. By cleats of wood or porcelain, and intervening air insulation.
4. By insulated metal saddles, in which case the conductors must be kept dry, and in sight.
5. By porcelain insulators—in sight.

We have here a broad and generous interpretation of the tenets that guide all insurers against risk from fire, and the fact that a reference is given to open work must be satisfactory to many who know what open work can be made.

We think, however, that in casing, there are many instances where it would be better for the two conductors to lie side by side, and the advantage of so arranging them was emphasised by Mr. Sidney Baynes at the Institution recently. If proper fuses are used, then the quicker a short develops itself the better, because it is not a sudden blow off that is to be feared so much as a sustained current of more moderate amount.

We are anxious to know if the interior conduit Mr. Bathurst has brought back to England with him is regarded as fireproof. Iron barrel is certainly fireproof, but cannot be considered arc-proof; and, although we have heard that the former was the cause of a certain installation being condemned by the fire office interested, it does not seem that surveyors have given this matter that attention it really merits.

Although these rules do not definitely press for a general adoption of the distributing board system carried out in its entirety, several of the remarks made show that it is very favourably regarded. Our readers will remember that we showed how Mr. Mackie had embodied this method in his wiring on the steamer *La Marguerite*, and how a number of contractors professed their adherence to the system. By carrying it out logically, joints are done away with. Where joints are necessary, the insulating sheath should certainly be vulcanised *in situ*, for, as Mr. Baynes says in his Rules, "Rubber joints will not permanently resist moisture unless vulcanised."

Mr. Heaphy has three things of which he is very fond. One is iron barrel as a protection to conductors; another, double-pole (or, rather, two single-pole) switches to every branch circuit; and the third, fittings and everything connected with the wiring of fireproof or non-combustible material. The latter two desires should certainly be met in

all cases; work done in compliance with them is better than that which does not so comply; but the insistance on the first is not quite so good. There are other things equally satisfactory with iron barrel, and less liable to cause faults. Mr. Swinton evidently has not found gas barrel altogether satisfactory.

The fire office rules, to which we will now return, state that arc lamps must be enclosed. So far good, but they go on to say that they should not be used where there are "combustible flyings." We thought that Mr. Dobson's experiments had settled this point. He showed in his paper on "The Artificial Lighting of Workshops," read at the Institution of Mechanical Engineers, that there is really no cause for apprehension on this score. Resistance coils are mentioned in connection with arc lamps. An omission seems to have been made in leaving out choking coils. As alternating stations are increasing in number, chokers are becoming common, and certainly require to be fixed as well and carefully as resistances. Resistance coils when wound spirally have been known to snap, and the live end or ends to fall against damp wall or earthed metal. It would be well that an asbestos or slate backing should be insisted on to avoid troubles from this cause.

In dealing with electromotors, the starting resistance has been rather overlooked. This is now-a-days frequently made a water resistance to meet the necessities of supply companies, but nothing is said about its construction here. A switch on each pole is specified as necessary, and it should not be possible to cut the whole of the current off and stop the motor without the use of the double-poled controlling switch. Those whose pressure is caused to "wobble" by motors operated on their circuits may have something to say about this.

Cooking and heating appliances are not pilloried as danger points. They should be raised on insulating stands, and provided with double-poled switches, while current for them should not be taken from lamp points. All very necessary.

The insulation resistance required is defined as the $\frac{1}{2000}$th of the maximum current when tested with 200 volts. This is equivalent to only 12 megohms per 8 C.P. lamp, and on an alternating system would be only one-half of that implied by the older Phœnix rules, supposing the lamp circuit to be 100 volts potential difference. As the Board of Trade rules now give about 1·6 megohns per lamp only, there does not seem to be a tendency to force the figure to an unduly high value, notwithstanding the stipulation of some of the supply companies and vestries that 100 megohms per lamp shall be obtained.

All insurance companies appear to dread service lines, and here there is evidence that the same timidity exists. Perhaps a fire that occurred some years ago, and burnt up the meters measuring the supply from the local company's mains to the Liverpool premises of this very insurance office, may have something to do with it, but that services are dreaded there is no doubt. Certainly where vulcanised joints connect the services to the distributors in the street (as is even yet customary in some places), there is danger, and some day the growing practice of using street service boxes with D.P. fuses on the services therein, will be a protection to the consumer, the supply and the insurer.

The St. Pancras Rules are very explicit, and can be readily summarised. Omitting any reference to common practice, we find, first, the somewhat startling innovation that the insulation resistance of all cable shall be 2,500 megohm-miles! Surely this is making the industry pay a heavy penalty for the privilege of using 220 volts. Yet we do know that wiring jobs only just completed have been done with 600 megohm-mile cable, and have been duly passed. No sal ammoniac may be used for tinning soldering irons; all joints and tappings must be kept 8 inches away from those of opposite polarity, and a pair of mains must be run for every 25 amperes. As this represents some 70 16-C.P. lamps the provision is a good one from many points of view. Double-poled (not pole) fuses are required on the mains, and every branch circuit, while switches, fuses and other distributing boards of opposite polarity must be separated by a space of at least 4 inches. The insulation resistance is 10 megohms per ampere of supply, or say 30 megohms per 16 C.P. 220-volt lamp.

It is very plainly stated that motors must be provided with starting resistances, and in the majority of cases they must be steadied by a fly-wheel. If the spirit of the rule on this point is carried out, the staff of the Vestry will require to be augmented, should motive power become a large and general thing, for full particulars of the motor, its use, fixing, fly-wheel, and other information has to be given to the engineer before laying it down. If all this is actually going to be investigated, then there is a large consulting practice awaiting the officials; but no doubt as yet motive power, especially with 220-volt supply, is growing but slowly.

Taking these two rules as they stand, they show a definite advance in the tendency to restrict only that which is objectionable in interior wiring, and to put clearly before contractors what they may and may not do while the present day practice and requirements are fully met. We only hope that they will be adhered to, and be ever present in the minds of the foremen and others actually carrying out work.

THE X RADIATION: INTERVIEW WITH MR. JACKSON.

Scientific men are often accused of prematurely publishing the results of incomplete investigations, but there is some excuse for this in the fact, which has been so often exemplified, that the too retiring and conscientious investigator may have the credit snatched from him by somebody who has, perhaps, come later into the same field. As long as it is the rule that first publication gives priority, the original researcher will usually find it advisable, in his own interest, to put on record his results at the earliest possible date.

Since 1890, Mr. Jackson, of the chemical laboratory, Kings College, London, has been engaged on an elaborate series of researches on phosphorescence, chiefly as produced by the Crookes tube. Like Tesla and many others, he derived his inspiration from the splendid experiments of Crookes. Like Lenard, he discovered, some years ago, that the radiation from the Crookes tube was capable of producing phosphorescence outside the tube, and of showing pictures on the phosphorescent screen of metallic objects enclosed in opaque boxes. He had not, it is true, made Röntgen's sensational discovery that the bones of the living body could be photographed, but this, from a purely theoretical point of view, is not of so much importance.

The great discovery of Röntgen, from a theoretical point of view, is the non-refrangibility of the X radiation. Although it is a rash thing, at this stage, to hazard any statement as to the nature of the X rays, all research up to the present appears to indicate that it was the same radiation with which Lenard, Jackson, and Röntgen obtained photographs or phosphorescent pictures of invisible objects. Of these three investigators, the work of Mr. Jackson is at present the least known, though, perhaps, not the least important. With the view of finding out something of Mr. Jackson's work in this field, we took occasion, the other day, to interview him.

Quite apart from his theoretical investigations on phosphorescence, Mr. Jackson has done more, perhaps, than anyone to make X ray photography a practical success. He is the inventor of the now well known focus tube which was recently described in the Electrical Review; and he has also, we believe, brought the phosphorescent screen to its present state of perfection. The focus tube is not an improvement on the Crookes tube used by Röntgen, but was invented and used by Mr. Jackson in his experiments on phosphorescence about two years before the publication of Röntgen's discovery. Mr. Jackson showed us a focus tube, corresponding in every respect with those at present in the market, which he had made in January, 1894.

The focus tube, as is well known to our readers, brings, by means of a concave cathode plate, the cathode rays to a focus on an anode plate which is set at an angle to the axis of the tube, so as to reflect the X rays out at one side of the tube. Mr. Jackson pointed out to us a very interesting peculiarity of the cone of cathode rays, which is quite visible to the eye when the vacuum is not extremely high. When a focus tube with a very high vacuum is heated gently by a Bunsen burner, the vacuum is considerably reduced, probably by the evaporation of a thin stratum of air condensed on the inside

of the walls of the tube. If the discharge is now sent through the tube, the cathode rays form a short blue cone with its base on the cathode plate, then they apparently cross at the apex of the cone and spread out on the other side, just as a beam of light does when brought to a focus by a lens. By removing the Bunsen lamp and allowing the focus tube slowly to cool, we observe a gradual change taking place in the cones formed by the cathode rays. The cone resting on the cathode plate slowly extends in length, while the outer cone formed by the rays after crossing at the focus, gradually decreases in diameter till it finally becomes a cylindrical pencil. The result of this transformation is that the focus of the cathode rays is considerably beyond the centre of curvature of the cathode plate, and that the rays are in focus for some distance beyond the apex of the cathode cone.

Mr. Jackson does not require to use the Sprengel pump in the manufacture of his X ray tubes—a very important point when we consider the long time required to exhaust by the mercury pump. The pump used by Mr. Jackson is a double Fleuss pump after an improved design of his own, in which the two piston cylinders are arranged in series. It is essentially a mechanical wash-out pump, and will produce a vacuum sufficient to resist an 8-inch spark.

Several peculiarities of the focus tube were shown by Mr. Jackson, in a striking and beautiful manner by means of the phosphorescent screen. For instance, if the screen is placed anywhere round the tube at right angles to the plane of the platinum reflector and intersecting it, the screen is dark on one side of the line of intersection, while on the other side of this line it phosphoresces with its full brilliancy. This shows that the X rays are reflected from the platinum plate with equal intensity in all directions, even in the plane of the plate itself, and that a very small percentage of the radiation passes through the plate. The green phosphorescence so characteristic of the efficient X ray tube, and which is generally attributed to the action of the X rays on the glass, is considered by Mr. Jackson to be due rather to the phosphorescence of the layer of air condensed on the surface of the glass; and the curious flickering sometimes observed in the phosphorescent light he attributes to the movement of this layer of air under the influence of the electrical discharge.

Mr. Jackson's focus tubes appear quite equal, if not superior, in intensity and penetrating power, even to the wonderful apparatus used by Tesla with a far more powerful source of energy. As we reported last week, Tesla states that he has obtained Röntgen photographs at a distance of 40 feet from a lamp excited by his powerful high frequency apparatus. Mr. Jackson showed us on the phosphorescent screen a distinct shadow of a bundle of wires contained in a leather brief bag at a distance of 20 feet from his little focus lamp excited by a five or six inch spark from an induction coil. There can be no doubt that photographs could be taken by this tube at 40 feet distance with a sufficiently long exposure. As to extreme rapidity of exposure, Mr. Jackson has taken Röntgen photographs of the hand in a small fraction of a second by placing the phosphorescent screen in contact with the sensitive plate. At moderate distances, without the use of the phosphorescent screen, beautiful sharply defined esographs of the hand can be taken in 1 to 2 minutes.

Mr. Jackson, who has now for some years been experimenting with a great variety of phosphorescent substances, has brought the phosphorescent screen to great perfection as an instrument for detecting the presence and intensity of the X radiation. He has found that the best substance to use is potassium platino cyanide. The tungstate of calcium, which formed the subject of Edison's sensational announcement, he has found, gives only about 50 per cent. of the intensity of light given out by the potassium platino cyanide. Edison's mistake was probably due to his using an insufficient quantity of the latter salt. Mr. Jackson uses about two-thirds of an ounce to cover a screen 6 inches in diameter. The finely powdered crystals are supported in a mucilaginous vehicle on a disc of black cardboard.

By means of Mr. Jackson's screen we were able to see distinctly the bones in the thickest parts of the human body. The ribs and backbone were distinctly visible, and also the knee and thigh joints. The bones of the hand, foot and forearm were, of course, brilliantly shown on the screen. Perhaps the section of the head shown on the phosphorescent disc was the most interesting. The jaw bones could be seen at work, and the fleshy point of the nose looked quite transparent; the outline of the skull could be seen, but there was nothing to indicate presence of brains inside. However, with quite a number of subjects this apparent hollowness can be demonstrated without the aid of X rays. The X rays, therefore, though they have already proved a great aid to the surgeon, have evidently their limitations.

What are the X rays? was the poser which we finally put to Mr. Jackson; but to this question he wished at present to reserve his complete answer, as he is engaged in the preparation of a paper embodying the results of his investigations on this subject. We can state this much, however, that Mr. Jackson favours the ultra-ultra-violet light view. The X rays according to this view are transverse vibrations like ordinary light waves, but of so extremely small amplitude that they are not refracted, polarised, &c., like ordinary light waves, because they are too small to be influenced by the atoms or molecules of matter. The cathode rays he believes to consist of transverse vibrations of every variety of amplitude and periodicity, analogous, in fact, to what is called a noise in the theory of sound. When this mixed aggregation of waves strikes against a solid body, such as the glass wall of the tube, it is transformed by the molecules into waves of a few definite periodicities. The X rays are the notes of highest periodicity and shortest amplitude. The appearance of Mr. Jackson's account of his investigations will, no doubt, excite the greatest interest.

INTERNATIONAL TELEGRAPH CONFERENCE OF 1896.

On June 16th next will take place at Buda-Pesth the quinquennial meeting of the delegates from the telegraph administrations of the Governments who have adhered to the International Telegraph Convention of St. Petersburg of 1875. The principal duty of the delegates at these Conferences is drafting and afterwards recommending their respective Governments to promulgate certain regulations for the proper carrying on of the international telegaph service between the interested states, and to incorporate in these regulations clauses to safeguard the public who use the international wires.

Although it may seem a strange mixture of duties to look after the interests of the treasury of the States represented, and at the same time to look after the interest of the telegraphing public who supply the funds to these treasuries, yet the international nature of these meetings and the divers interests, oftentimes rival, represented there, ensure fair treatment for the general public.

So it has happened. Each Conference has procured advantages for the public.

While the States are present at these Conferences by their delegates, the latter have recognised the great services rendered to international telegraphy by submarine cables and private enterprises, and always invite the representatives of the companies owning lines of communication to be present and take part in the debates at the Conferences, and to submit such propositions or observations as they may think expedient. As the representatives of the companies have no official position at the Conferences, they have naturally no vote. The very weakness of the companies in this respect is their strength, as the delegates always show a kindly deference towards these representatives, and duly weigh the great interests the companies have at stake before adopting any resolution which may endanger the well being of some of the most necessary lines of international communication.

To the public the Conference of Buda-Pesth will be one of the most important ever held, on account of the very advantageous, if somewhat radical, proposition which the German Government will bring forward. The kernel of this proposition is an unified tariff per word between all European countries. The simplicity and grasp of the subject shown in the German proposition must be apparent to all who have studied the question, and the profound analysis of this proposition made by the officials of the Berne International

Office demands great respect for its ability and thoroughness. The amendments to the German proposal suggested by the Berne office are well worthy of the best attention of the different administrations. In the development of the German proposition as suggested by the Berne office there seems to be no great difficulty in the way of unification of the tariffs for international European service, so far as the land-line service of the interested States is concerned. The outcome of this unification, however, would be a reduction of rates forced on the telegraph companies. If one accepts these companies' statements, this loss would be so serious that the maintenance of their existing submarine system would be jeopardised, and perhaps even rendered impossible. To judge from the treatment hitherto received by the companies at the various Conferences, the delegates will be very loath to take any step which would bring about this state of things. In the first case these submarine lines have created for themselves a well-deserved reputation for celerity and correctness of transmission, and in the second place a duplicate or triplicate submarine cable route is not so liable to interruption as the overland routes, in which atmospheric disturbances continually paralyse their usefulness and render their working uncertain.

If, therefore, the owners of these submarine lines, by the action of the delegates, have their revenue so reduced as to be unable to maintain and work them, a serious blow will be given to international telegraphy. No doubt these considerations are fully in the minds of the administrations, but it seems a pity that such a state of things should stand in the way of the great advantage Germany would confer on the telegraphing public.

In our view the existing management of the European international telegraph system is too decentralised to give the best facilities to the public, and we therefore think it should be centralised, and that this centralisation should take place by extending the scope of the Berne office, and by making it the Administration Centrale de Télégraphie Internationale Européenne.

Let us suppose that all the present international wires were handed over by the different states to this Administration Centrale, and that the assessed value of these wires should represent in the combination the interest of each State. Let us suppose that this Administration Centrale purchased all the existing European cables, and made them part of its system. We should have an organisation which could deal with international European telegraphy under one head, and all questions of international accounts would disappear. The details of such a scheme should not be difficult to work out. The Centrale would have power given it by the States in quinquennial meeting or conference to make contracts with each individual State for the erection and maintenance of the Centrale's wires in its territory. The contracts could be based on a mileage of line. The Centrale's clerks should work the Centrale's wires, should be furnished by the different States in proportion to their interests, and should be specially trained in a knowledge of languages. The receipts for international traffic should go into the Centrale's purse.

The Centrale's wires should connect such large towns in Europe as the service demands, and any international traffic originating in, or destined to, offices other than the Centrale's offices, should be carried by the States in which this occurs free of cost, or at some very small rate to be agreed upon. Every year the Centrale should furnish the contributory States with a report of the surplus or deficit to be divided among the contributories.

If this centralisation of management of the international wires of Europe took place, such a proposition as now made by Germany would find no difficulties in its way. As the interest in the Centrale held by each of the States would be determined by the value of the lines and offices handed over to the Centrale by that State, the proportion which that State would have to pay for the pre-emption of the European cables could be determined. For an approximate valuation of the cables to be purchased, £120 per mile per conductor may be adopted, and the total amount to be raised to complete the purchase could, it appears to us, be readily obtained by a joint guarantee of all these States at probably 2 per cent. interest. Another argument in favour of this centralisation scheme is, that it would give the best guarantee for the neutrality of cables in war time, and, in addition to the abolition of international accounts, friction between administrations as to who was at fault for a badly working international wire would be avoided.

We venture to lay these suggestions before the delegates with all the omissions of detail unavoidable in an article such as this, but we hope we have made them sufficiently clear to allow of the idea being understood. We now leave the matter to those competent to deal with it.

THE INCANDESCENT LAMP REGULATOR OF MACFARLAN MOORE.

Our readers can hardly have forgotten Mr. Budworth Sharpe and his "epoch-making discoveries" in the regulation of electric lamps, which were, according to the daily press, to "revolutionise" the domestic use of electricity. Really useful regulators have been devised by Diehl—a variable resistance that could be got into a rather exaggerated lampholder—and by Ries, who inserted a small choking coil in a key socket, and arranged tappings from it to a switch, so that the impedence could be varied at will. The Edison-Swan Company have quite recently brought out a lamp with a miniature switch in the lamp itself, and as the lamp has two filaments, one of 8-C.P. and the other of 16-C.P., the user is enabled to obtain 8-C.P. or 16-C.P., as he may find desirable. These devices show that inventors and manufacturers consider that the public desire to be able to "turn down the electric light," although, for our own part, we fail to see what advantage is gained, when it is such a ridiculously simple matter to turn on the light required when it is wanted, and to turn it off—and thereby stop all consumption of electrical energy—when done with.

C.P. of lamp.	P.D. at lamp.	P.D. on rheostat.	Current.	R. Power in lamp.	Power in rheostat.	Total power.	Per cent. saved.	T. Current in lamp.	Equivalent current.
17·0	115·0	0·	0·62	71·3	0·	71 3	0·	0·	...
10·0	104·0	11·0	0 53	55·1	5·8	60 9	14·6	0·48	0·53
7·8	99·5	15 0	0·50	49 8	7 8	57 6	19·2	0·43	0·50
5·6	95·0	20·0	0·47	44·7	9·4	54·1	24·1	0·39	...
4·0	91 0	24·0	0 45	41·0	10 8	51·8	27·3	0·36	0 38
3·2	85·0	30·0	0·42	35·7	12·6	48·3	32·5	0 31	0 32
1·1	75·5	39·5	0·36	27·2	14·2	41·4	41 9	0·24	0 26
0·33	65·0	50·0	0·30	19·5	15 0	34 5	51·6	0 17	0 19
0·14	57·5	57·5	0 26	15·2	15·2	30 4	57·3	0·13	0 15
0 02	45·0	70·0	0·20	9 0	14·0	23·0	67·7	0·08	...

R = with rheostat. T = with trembler.

Mr. Macfarlan Moore has proceeded to attack the regulation problem in another direction. His device consists of a sort of trembling contact in circuit with a lamp. The object of this is to interrupt the current during a fraction of the time that the circuit is closed, to close the circuit and again open it, and to repeat this operation indefinitely. The interruptions are made so rapid that they have no influence upon the constancy of the light, as the filament acts as a kind of thermal fly-wheel. The trembler is composed of a small electro-magnet, about half-an-inch in diameter; opposite the pole of the magnet, and enclosed in an exhausted glass vessel, is a light armature carried by a spring, and as this vibrates, it opens and closes the circuit in the manner of an electric bell. The glass vessel is a tube about an inch in length and a third of an inch in diameter. In spite of such Lilliputian dimension, the spark at breaking

is barely visible, and the apparatus does not heat to any extent.

Prof. Anthony has tested this device against equivalent regulation by a rheostat. His figures are given shortly in the table.

The saving is approximately 50 per cent. greater with the Moore device, as compared with the rheostat. Of course, any device of the kind must be relatively inefficient, as the candle-power of an incandescent lamp varies approximately with the sixth power of the current. The general public have only to open their minds to an understanding of this fact, and regulators will be tabooed as energy-eaters. The fact was brought home to many by the clear exposition given by Prof. Fleming in his lectures on "Electrical Illumination" at the Royal Institution some time ago.

Mr. Moore has certainly produced an ingenious arrangement, and one which, provided it can be relied upon to perform its functions for months at a time, meets the conditions for economy better than any other. In his apparatus, the spring is so weak that if the armature lies horizontally and in contact, the attraction of the magnet is not powerful enough to raise it, even when the maximum current is passing. When the candle-power is small, the light given by the lamp, reduced by the interrupter, is stable and constant, but with larger current the effect is not so good. At the lowest reading the filament of the lamp tested was quite visible with 0·05 ampere, with the trembler as regulator, whereas when a rheostat was used, the current was three times as much, or ·15 ampere. A few weeks ago we described the use Mr. Moore put similar devices to in obtaining what he is pleased to term "etheric light."

REVIEWS.

Engineering Estimates and Cost Accounts. By Francis G. Burton. Manchester, 1896: The Technical Publishing Company.

The author of this book, formerly manager of a shipbuilding yard, naturally illustrates his arguments with the details of his special business, and in doing so has allowed himself to be carried into a too great detail which, to some extent, has prevented him writing a book on general principles. At best it is difficult to write on engineering costs, at the same time the author is a man of experience and has given good advice and instruction. His remarks on indirect costs and interest charges are good. We have in mind now a prosperous firm whose indirect charges are levied on work at so exorbitant a rate that no single job has shown a book profit for many years. One partner spends all his time in planning how to show a loss on work, for the benefit of the staff, who are thereby supposed to be content with small salaries, and to look on their principals as magnanimous philanthropists who run the works solely for the sake of keeping alive a lot of employés. The evil of this course, from a business point of view, is that it tends to add to the tendered prices for work, and less foolish competitors who tender honest prices get the work. The final result may be to reduce work to so small an amount that even the too high indirect expenses become only too low from the small area over which at last they are spread. Obviously, the proper thing to do is to fix indirect expenses at a figure consistent with the proper weight of turnover and then to push business until the turnover is of such weight as to reduce indirect expenses to as low a figure as chosen.

No one will find fault with a correct system of bookkeeping as a means to tendering a correct price for future work, but there is always a dangerous tendency among those who allow themselves to be unduly influenced by academical charges and losses, to exaggerate these items and to allow them to hinder the obtaining of genuine paying business. Thus it costs 4s. apiece to buy certain articles from the specialist country makers. To manufacture same in London costs in materials and net wages 3s. 6d., but when charged with the indirect expenses and interest the cost figures out to 4s. 6d. each. Now, the academical men who sit in offices and blind themselves with figures think they save sixpence by buying outside for 4s. what costs in the books 4s. 6d. If they were not so wedded to their folly they would see that by utilising a lathe, which is an absolute necessity in the business, but can only be kept running half its time, and by working a turner to his full capacity, who is now often hard pushed to keep up an appearance of work, they would really be making these articles for the price of 3s. 6d. and saving a 6d. of the outside price to go towards general indirect expenses. As it is, they buy outside and the indirect expenses go on all the same with not even the 6d. towards them. Our author appears, if we may read between the lines, to have had, at some time, an experience with this unfortunate and unsatisfactory class of principal. It is at least satisfactory to find him laying so much and so frequent stress on the avoidance of the error. The book will not become a classic on the subject of cost, but it may be read with advantage by men who are called on to conduct an engineering business, the first requisite in which is to get work and enough of it. To successfully run a manufacturing business, one must first cut down general expenses to a reasonable minimum, and next proportion the work, rather than the prices, to the expenses. This implies progress; the other way spells ruin, sooner or later, in any business of the slightest competitive nature.

Alternating and Interrupted Electric Currents. By Prof. G. Forbes, M.A., F.R.S.. London: Biggs & Co., Salisbury Court, Fleet Street.

This book is based on a series of three lectures delivered before the Royal Institution in 1895. It is not a book, as might be at first imagined, dealing chiefly with the subject from an electric light or power point of view. Mechanical analogues of the action of currents are largely made use of, and with great advantage, the description of a mechanical torsion model of a submarine cable being particularly interesting. The lectures might perhaps have been more appropriately been entitled lectures on static and electro-magnetic induction, as they chiefly relate to the description of experiments, on a large scale, of the phenomena resulting from inductive action. The republication of the lectures in a book form is much to be commended.

The Mechanical World Pocket Diary. Manchester: Emmott and Co., Limited, New Bridge Street.

The ninth annual issue of this compilation shows some improvement over the previous issues, but the arrangement of the book is bad. For example, we have a table of the weight and specific gravity of metals placed amongst conversion tables of lengths and weights, and tables of square roots, &c., this table is obviously inappropriate in such a position. The notes on gas engines are brief and not particularly valuable, they might be rewritten and amplified with advantage. Steam and the steam engine forms the bulk of the book and this section contains a very good assortment of matter, both in the form of formulæ and of tables. Taking the work as a whole it is an excellent sixpennyworth, containing a vast amount of useful matter.

Physical Units. By Magnus Maclean, M.A., D.Sc. London: Biggs & Co., Salisbury Court, Fleet Street.

This book is mainly a reprint of a series of articles published in the *Electrical Engineer* in 1894, but additions have been made in the shape of a number of tables of various physical constants, including one of the resistance of copper wire at 15° C.; these tables are 32 in number. In dealing with the relative values of the British and metric units it would have been interesting if the degree of accuracy to which the values could be relied upon had been stated. The value of the yard in terms of the metre, for instance, is given to 8 places of decimals when 5 is probably the limit. The practice of expressing values to a large number of decimal places is a common and very absurd one, and, moreover, it gives a false impression of accuracy.

Journal of the Institution of Electrical Engineers, No. 119. London: E. & F. N. Spon, 125, Strand.

The chief contents of this number are as follows:—"The Electric Wiring Question," by F. Bathurst; "Concentric Wiring," by S. Mavor; "Annual Report of the Council."

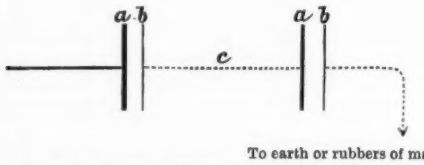
University Correspondence Calendar, 1895-96. London: 32, Red Lion Square.

The annual report in this calendar shows that a very substantial increase has taken place in the total number of students of the Correspondence College who have passed the London University Examinations, this number for the 12 months ending July, 1895, being 777; other satisfactory evidence is given of the good work being done by the college; 35 students, it may be mentioned, took the B.Sc. degree.

CORRESPONDENCE.

Seeing by Electricity.

Sir,—In a pleasurable conversation we had together a few days ago on Röntgen rays and other allied effects, I incidentally referred to experiments I had made on the subject of "Seeing by Electricity," and it is at your request, and through the great interest you displayed, that I venture to submit for publication the following brief facts—facts which I have proved to you by an inspection of my laboratory note books and a few photographs of simple results.



(*a*), Iron plate joined to prime conductor of small frictional machine; (*b*), Tin foil disc painted with Balmain's luminous paint; (*c*), Insulated conductor.

Since May, 1880, I have had a peculiar fascination for the idea of "Seeing by Electricity," and made many experiments at odd times during the long interval between then and now; but I fear my crude appliances have, in the most important part of my research, been cruel deceivers. In May, 1880, I attempted to ascertain what would be the effect of acting inductively, by high tension electricity, upon phosphorescent matter, and, for the purpose of the following experiment, obtained a small bottle of Balmain's luminous powder, some of which I have still in my possession.

No visible change. A note follows:—"That an ordinary negative photograph placed between inducing and induced plates may produce at distant point some resemblance to picture. Perhaps suitable reflectors could be made to throw an image upon chemically prepared glass plate while under induction, and as the light acts upon sensitive chemical, so it might upon luminous paint substance, resulting in a similar change on remote diaphragm." Another note says:—"Darkness essential, examine the condition of phosphorescent body with good magnifying lens." This was, unfortunately, not tried.

Various experiments were made by me with chemically prepared papers sensitive to change by electric currents in order to find something which very small currents would effect. Several successful results were obtained; but the best effect of all was obtained with ordinary photographic plates in April, 1893, by my son (Harry) and myself. We merely *damped* with *distilled* water an Ilford dry ¼ plate, and placed thereon two three-prong pieces of tinfoil thus:—

These were joined to a battery of three very small accumulator cells (in indifferent condition) for one minute. On "developing" the Ilford plate with pyrogallic acid and ammonia, the shape of both tin foil electrodes—one more dense than the other—became visible, and a faint line of action could be seen starting out from the most distant pattern towards the one less apparent. Fig. 1 is a print of the negative.

Experiment 2.—We next placed a star-shaped piece of tin foil inside an annular ring of the same substance. The star was joined to the peroxide pole of the same little battery for 3½ minutes. After "developing," the star was seen to be more dense than the annular ring. On the same plate we also put a halfpenny and a sixpence, and simply connected them by a copper wire for *five* minutes. Fig. 2 is a copy of the print from the negative plate.

Considering the enormous resistance that the mere film of *distilled* water must have presented, it will be self-evident how infinitesimal the strength of current must have been,

Fig. 1.

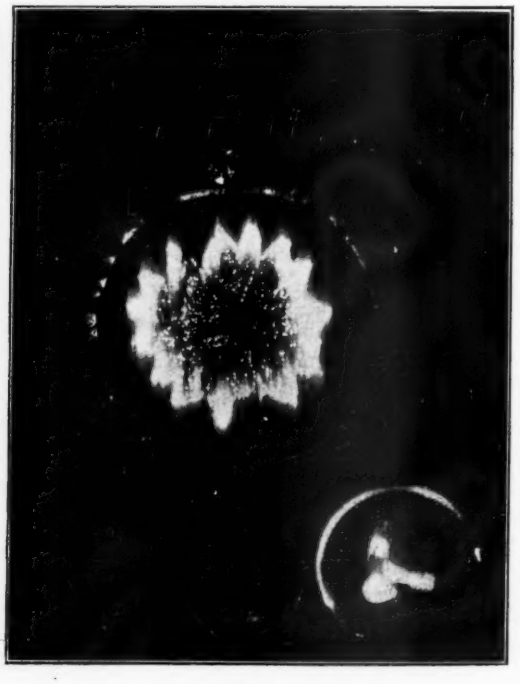


Fig. 2.

and therefore how extremely sensitive photographic plates are to electric currents.

I partly prepared apparatus for further investigating this interesting subject, but, up to the present, inevitable causes have led me to postpone the work.

Without the slightest egotism I think we have in the foregoing statements the ideal of high-tension electricity affecting phosphorescent matter, and, stimulated by your courtesy and desire to publish my feeble efforts, I now show how very sensitive ordinary photographic plates are to exceedingly minute currents of electricity. Much is to be done in the direction of telephotography and "seeing by electricity," and I hope these few notes will be as acceptable to others as your encouraging remarks have been to me.

I. Probert.

March 28th, 1896.

Concentric Cables.

I should be greatly obliged if you could put me right on a matter in which I am a bit hazy.

Am I right in supposing that in an alternate circuit of, say, 2,000 v. (that is to say $\frac{2{,}000 +}{1{,}000 -}$ giving as a difference of 2,000 v.) if anyone touched a part of that circuit?

If *the outer were earthed* he would get 2,000 v. to earth?

If the *circuit was not earthed* he would get only 1,000 v. to earth?

P. S. Clay.

[The maximum E.M.F. + or — in a circuit of 2,000 volts virtual is

$$\frac{1}{\cdot 707}\sqrt{\text{mean}^2},$$

or, approximately, 1·4 times the virtual volts. That is, the maximum is about 2,800 volts, and this changes sign with every alternation. Assuming the cable to be concentric, if the outer were earthed and anyone touched the outer, he would get no pressure to earth and 2,000 volts from the inner to earth. If the circuit was not earthed, he would get nothing from outer to earth (all being well insulated), and an initial 2,000 volts from inner to earth. Maintaining the contact, a capacity current would flow sufficient to keep the inner at earth potential. The question is dealt with more fully on another page.—Eds. Elec. Rev.]

Concentric Cables v. Bare Strip.

Your space is far too valuable to be taken up with a discussion, which is now becoming personal, and this letter, therefore, closes the matter so far as I am concerned.

I am sorry that J. H. should think that I designated him a "culpable fool"; I had no intention of doing so, and I think if he will read my letter again, he will see that "culpable folly" was imputed, not to those persons who made joints on live concentric cables, but only to those who did so when these cables carried a current under high pressure.

I do not suppose that the intelligent jointer would convert his cable into a double chimney sweep's brush. My contention was that these pieces of wire, some 5 inches long, had to be turned back and cut off, and in turning them back there was danger of a short circuit being made; of course, if the bridging piece is insulated, the matter is altered, but the sketch J. H. sent me did not say that this insulation existed. Your correspondent evidently thinks that cost is not a practical question. I cannot agree with him, but do not wish to press the point.

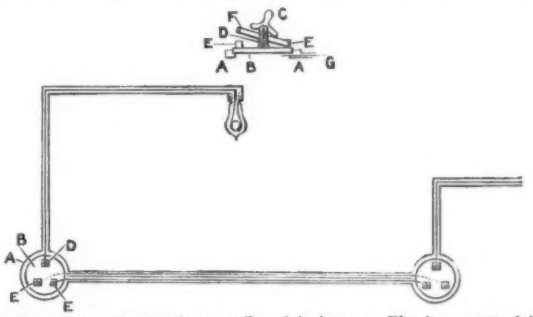
Another very serious objection which certainly would weigh greatly with me from a practical point of view, is the number of joints that the apparatus, of which J. H. sent me a description, necessitates in the main conductor. It requires, if I mistake not, four clamped joints in the main outer conductor at every T-joint, and, since these joints occur every few yards, the loss of pressure due to the joints can hardly fail to be considerable in a long street.

Let us bury the hatchet and retain our original opinions, for even now I should hesitate to put an ordinary jointer on to the work in question.

The Writer of the Article.

The Wiring Question.

Re G. C. Allingham's query, page 375, Electrical Review, for March 20th. I do not know Mr. Mavor's system but enclose sketch showing concentric wires and switches for passage light to be switched on or off from



A, Brass ring with trunnions; B, Porcelain base; C, Ebonite or porcelain handle; D, Brass post; E, Contact plates with terminal screws; F, Brass knife; G, Insulated conductor.

either end, and it appears to me to be quite as simple as the same thing on two-wire system, and the switches, such as shown, would not be more expensive or difficult to make than an ordinary concentric switch.

L. Russell.

Dynamo Calculation.

This is the second time I have asked for an answer to the following question, and as I have now been a subscriber to the Electrical Review for 12 years, I trust my favour will be allowed. There are a large number who are the same as myself, viz., cannot understand the letters and signs, and therefore are hindered from full benefits of your report of experiment and explanations. Now for my question:

Can you give me a full (simple arithmetic) formula for the calculation of a dynamo? Take for example, say an overtype to work at 100 amperes, 240 volts, 700 revolutions per minute. I, along with other subscribers, will watch for the answer. We have had all the books we can get hold of, and have watched your paper for years, and have not been able to solve the problem. They are all signs and letters; these are useless to students. We trust you will give us a complete set of figures designing the above, so that we can follow your figures, and be able to calculate other sizes in the same way. In reference to magnet, take Allen steel for their material, Kapp type. Trust we shall be favoured this once in 12 years.

Student.

[Articles innumerable on dynamo designing have appeared in the Review. A series of articles would be required of a very elementary nature to begin with, and gradually leading up to actual designs, to teach even the rudiments of the subject. The last work of Mr. Gisbert Kapp on "Dynamos and Alternators" gives full arithmetical formula and examples, and we think "Student" cannot do better than get hold of that book. If he cannot understand Kapp, it will be necessary for him to attend a class or employ a teacher to improve his elementary education. We don't think any articles written on the subject of a more simple nature than are to be found in Kapp's book would enable "Student" to design a 24 k.w. dynamo, and to calculate other sizes.—Eds. Elec. Rev.]

Differential and Integral Calculus.

"Easy Lessons in the Differential Calculus," by R. A. Procter, published at 2s. 6d. by Longmans, is a book, such as "D. T." enquires for in his letter last week. It deals with the elements of the subject in a very intelligible manner. My copy, published in 1887, contains a number of misprints, which are, however, obvious to anyone reading the book carefully.

T. H. M.

April 6th, 1896.

Procter's "Easy Lessons in the Differential Calculus," Longmans, price 2s. 6d., would be a very suitable work for "D. T."

H. W. W. Dix.

April 2nd, 1896.

Some Recent Dynamos.

Quite possibly the dynamo of Messrs. Paterson & Cooper's manufacture, shown in fig. 1, p. 336 of your issue of 20th ult., resembles, in a general way, dynamos which have been made by Messrs Schuckert, of Nuremburg. How near the resemblance may be I do not know, never having seen any of Messrs. Schuckert's machines. Both the dynamos illustrated in the article referred to resemble more or less machines which have been made by a great many firms, but if all these firms require you to announce the interesting fact in your columns you will have no room for any other matter.

The distinctive characteristics of a dynamo do not reside in its personal appearance, but rather in its constructive details and proportions. If your correspondent means that the details and proportions of the dynamo mentioned agree with those of some particular machine which Messrs. Schuckert have made, the coincidence may be worth recording, otherwise his letter is superfluous.

Claude W. Hill, A.M.I.C.E., M.I.E.E.

[Mr. Hill's letter seems quite to the point.—Eds. Elec. Rev.]

Important Contradiction.

A former employé—in fact, one whom I have taught my trade—is spreading a report that I had swindled him out of his late father's business, the said business being that of an electrical wire-coverer, and the goodwill I bought of his mother in 1872 for cash. As these reports are calculated to do my untarnished name unmeasurable harm, I should feel greatly indebted if you could make it known that there is not a shadow of truth in the above statement.

A. Koerber.

Electrolytic Separation of Metals.

In the *Engineering and Mining Journal* I noticed an article referring to an article which appeared in your journal on the electrolytic separation of metals, by E. T. Smith and D. L. Wallace, with whom I would like to communicate, as I am heavily interested in mining property, of which the ores contain gold, silver, cobalt, nickel, bismuth, platinum, and aluminium. These metals are in paying quantities, assaying from $493 to $1,500 to the ton. We have two local gentlemen who have patented a process for electrolytic separation of metals, and we are building a mill, adopting their process, known as "the Brown and Bourgon." Should this fail or be successful, still we would like to learn with regard to Messrs. Smith and Wallace's process, and the particulars relative to the adoption of the same, because there are several companies in the same mountain range developing their property, with the hopes of being able to segregate the metals. There is a wide field for their discoveries here in Utah, and a splendid harvest for them, should they be successful in separating the metals named. Your attention to this will be a boon to the mining industry of Utah.

Duncan McFadyen,
c/o Z. C. M. I., Salt Lake City, Utah, America.

March 21st, 1896.

Secondary Battery Plates.

With reference to the letter of Mr. Barber Starkey under this heading, it is well-known that chromic acid (H_2 Cr O_4) will, in the same way as sulphuric acid (H_2 S O_4), cause a plate or cake of monoxide of lead to "set," *i.e.*, it will harden and prevent it from disintegrating. The use of chromates for this purpose is claimed in my patent No. 4,671, 1885, which is still in force. Chromic acid, in solution, is of itself incapable of converting monoxide of lead into peroxide. It simply forms with it a chromate, according to the equation:

$$Pb\,O + H_2\,Cr\,O_4 = Pb\,Cr\,O_4 + H_2\,O,$$

or, more usually in practice, a basic chromate.

Desmond G. Fitz-Gerald.

Wiring Table Wanted.

Do you know of any table giving the area and nearest size of cable at 800 amperes, as well as 1,000 amperes per square inch? We have plenty at 1,000, but want one suitable for wiremen's use without calculation at 800 amperes.

The Midland Electric Company.

[Possibly some of the wiring contractors or others of our readers could furnish the required table.—Eds. Elec. Rev.]

An Error in the Design of Electrical Plant.

In your issue of March 27th, Mr. Booth takes exception to electrical engineers statements that mill engines will not drive dynamos satisfactorily.

It is quite true that in a mill with several thousands spindles running, the variation of speed during each revolution of the engine cannot be detected by the ear, but it is most distinctly heard at the main gearing driving the spinning room, and where rope driving is used every stroke of the engine can be seen on the ropes.

Now if a modern high speed electric light engine is used to drive the saw mill, no variation is heard in the gearing, and with ropes they run so steadily, that, from a short distance off, they appear to be at rest.

I know of a case where a high speed single acting electric light engine, of about 600 H.P., has replaced an ordinary mill engine, with the result that, owing to steady driving, the speed of the spindles was increased 12½ per cent.

This may not prove that mill engines will not run dynamos, but I think it proves that electric light engines can even beat the former at their own work.

Mr. Booth's remarks *re* fly-wheels are on the assumption that dynamos are subject to sudden and large alterations of load, a state of things which does not occur in a central station, where the load is always put on gradually and taken off in the same way, so that it is quite useless to put on a fly-wheel to mar alterations of this sort.

C. O. Grimshaw.

April 8th.

BUSINESS NOTICES, &c.

Bankruptcy Proceedings.—In the Edinburgh Bankruptcy Court, on 31st ult., William Gray, jun., ironmonger, 52, Frederick Street, carrying on business there under the styles of the Scottish Electrical Engineering Company and Gray & Son, ironmongers, of both of which firms he is the sole partner, appeared for examination in bankruptcy. Mr. C. J. Munro, C.A., trustee, asked for an adjournment, stating that the bankrupt had intimated that he intended to submit an offer of composition to his creditors. The state of affairs submitted by the bankrupt showed assets amounting to £2,291 4s. 2d., and liabilities £2,700 17s. 11d., giving a deficiency of £409 13s. 9d.

Liquidation Notice.—Notice is given in the *London Gazette* that a general meeting of the members of the Arcas Plating Co., Limited, will be held on May 5th, at 3 o'clock p.m., at the offices of Messrs. Pratt & Norton, 9, Old Jewry Chambers, London, E.C., to have an account of the winding up proceedings laid before it, and to conduct business usual at such meetings.

Dissolution of Partnership.—Messrs. F. C. Allsop and C. W. Treacher, hitherto carrying on business as electric lighting engineers and contractors, under the style of F. C. Allsop & Co., at 165, Queen Victoria Street, London, E.C., have dissolved partnership by mutual consent. Debts will be attended to by C. W. Treacher.

Electrical Engineering in Austria and Hungary.—The report of the Budapest Electric Stadtbahn Company, for 1895, shows a profit of £55,063, which will admit of a dividend of 10 per cent., as against 9 per cent. for 1894.

Interior Conduit.—We are advised that Messrs. Strode and Co. have secured the contract for the wiring (900 lights) of the Trocadero Restaurant, Great Windmill Street, Piccadilly, which is being built for Messrs. Lyons & Co. The installation is being carried out under the direction of Mr. Martin Roberts, consulting engineer. Iron armoured conduits, which, as our readers are aware, consist of an insulating tube placed within an ordinary iron pipe, have been specified. This firm has recently finished the wiring of the Hans Place Hotel, Sloane Street (800 lights), using this same material. Messrs. Kincaid, Waller & Manville were the consulting engineers in this case. Amongst the more important country installations recently equipped with interior conduit we might mention the following:—Stafford Infirmary, Manchester and District Bank Building (Messrs. Drake & Gorham, contractors); Montpelier Baths,

Harrowgate (Messrs. Paterson & Cooper, contractors); Cardiff Technical Schools (Messrs. Clay Bros., contractors); Exeter Museum extension building (The Electrical and General Engineering Co., contractors); the Law Union and Crown Life Insurance Co.'s Buildings, Manchester (Messrs. Geo. Hill & Co., contractors); and many country house installations in all parts of England by other prominent contractors. Mr. F. Bathurst further reports other important contracts pending or in negotiation. The above will suffice to prove that the interior conduit system is making sure headway, and that architects, contractors, and owners alike are beginning to find out its particular suitability to any new building work. The General Electric Co., who are stocking the material and accessories, find that with the increasing demand they are able to quote closer prices, and consider that wiring work, carried out with armoured insulating tubes, is already competing in price with that employing ordinary metal pipe construction. There are many difficulties and disadvantages to be encountered in the introduction of new material for use in electric wiring, but it would appear that this insulating tubing has a large field of usefulness before it.

John Shaw & Co.—Messrs. John Shaw & Co., of Glasgow, makers of cast-iron pipes, &c., announce that they have re-opened their office at 6, Lombard Court, London, E.C., and will, in future, be represented, both for the export and home trade, by the junior partner, Mr. Hugh Girvan.

Messrs. Crompton's Works.—With reference to our short paragraph regarding Messrs. Crompton & Co., Limited, and the Chelmsford Town Council, Mr. R. Britton writes as follows:—"There is no hitch between the Council and Crompton & Co. The desire of every member of the Council, I believe, is to keep the works at Chelmsford, and would do all in their power to assist in that direction, if it lay in their power. I thought, as Chairman of the Lighting Committee, it was my duty to inform you of the above facts, as the circulation of your paper is so great it may convey to those outside that the Council wished to be rid of the works, when it is exactly the opposite. To try to drive Crompton & Co. away would be to my mind suicidal, as the town cannot afford to lose such customers."

Safety Wall Plugs.—Messrs. Hodges & Todd write as follows:—"Referring to your correspondent's allusion to the safety wall sockets, illustrated in your issue of March 20th, we beg to say that we have no doubt there have been attempts made to introduce a type of side contact wall plug, but what we claim is that ours is the only safety side contact wall plug *on the market*."

Telephonic Apparatus.—The National Telephone Company is issuing circulars stating that it is now prepared to erect and sell outright installations of telephones in warehouses, stores, offices, hospitals, asylums, &c., and to maintain same upon a small annual payment. The company has already fitted a number of public buildings on this principle.

Yost Typewriters.—In consequence of the increase of business in the South Wales district, the Yost Typewriter Company, Limited, has found it necessary to establish a branch at 77, St. Mary Street, Cardiff.

ELECTRIC LIGHTING NOTES.

Aberdeen.—The Newcastle and Hull Steam Company want to lay a private wire from the electric main to their premises in Mearns Street. A committee is considering the matter.

Ambleside.—The District Council has ordered inquiries to be made regarding electric lighting, with a view to securing parliamentary powers.

Bolton.—The resignation of Mr. J. H. Rider, the chief electrical engineer to the Corporation, formed one of the topics discussed at the Town Council meeting held on the 1st inst. A good deal was made of the fact that the Gas and Electricity Committee refused last year to advance Mr. Rider's salary to £300, whilst now they offer that sum for a successor. It was pointed out by those criticising the action of the committee that Mr. Rider designed the electrical works, and had carried out the whole scheme with credit to himself and to the Corporation, achievements which, in their opinion, entitled him to generous consideration at their hands in regard to salary. Several members spoke highly of Mr. Rider's ability, and the Council was assured by members of the Gas Committee that there was a genuine feeling of regret on their part at Mr. Rider's impending departure. It was also explained that the £300 was being offered at Mr. Rider's suggestion, and that the reason why that gentleman's application for an advance last year was not considered, was because of an expressed desire on the part of the Finance Committee that no advances should be granted during that financial year. Councillor Proctor, and one or two others, remarked that this policy had lost the Corporation an excellent servant. Other departments were urged to profit by this experience, and recognise the value of good servants. An amendment that the salary of Mr. Rider's successor be left open was defeated by 23 votes to 16.

Belfast.—We stated last week that a profit of £300 had been earned on the electric light undertaking during 1895. We since learn that the profit shown is £385, without allowing for interest or sinking fund on the capital of the undertaking, or for depreciation.

Brighton.—The mains are to be extended along Islingwood Road. The Council, on Tuesday, voted £27,500 capital required in connection with the electric lighting.

Cambuslang.—It is said, remarks a Glasgow paper, that by next winter the streets of Cambuslang will be lit by electric light. The necessary power to set the scheme in operation will be got from the River Clyde, about 500 yards distant from the main street.

Cheltenham.—On 27th ult. a Local Government Board inquiry was held here regarding the Corporation's application to borrow £20,000 for electric lighting.

The minutes of the Lighting Committee adopted this week by the Council recommend that the lamps between Thirlestain Road and the Norwood Arms be replaced by electric incandescent lamps as an experiment. The electric inspector had reported that four tests of the low pressure cables showed the supply to be 103, 102, 103, and 103 volts respectively, the legal standard being 100 volts. The electrical engineer reported that the number of 8 candle-power lamps connected to the mains was 6,150, and the number waiting to be connected about 700. It was resolved on the recommendation of the engineer, that the supply of service cable required during the remainder of the year be obtained from Messrs. Callender at the price quoted by them, and that the London Road extension be proceeded with. Alderman Norman, who moved the adoption of the minutes, said that Mr. Kilgour had furnished him with some careful analyses, from which he gathered that the expenditure of coal at the station during three weeks in February, when the destructor was not in use, was 50·35 tons, and during three weeks in March, when it was in use, 30·10 tons. But the output of current in March being necessarily less in the longer days of that month than in those of February—6,990 against 8,597 B.T.U.—Mr. Kilgour had also reckoned the proportion of coal consumed per unit, and this came out as 9·33 in March, with the destructor assisting, as against 13·11 in February.

Coventry.—The Electric Light Committee has decided to adopt the recommendations of Mr. R. Hammond, and considerably extend the plant at the generating station.

Edinburgh.—The Catholic Apostolic Church, in Mansfield Place, has been fitted with an installation of 160 lamps of 8 and 16 C.P.

The Electric Lighting Committee has provisionally estimated that the expenditure for electric lighting for the year 1896-97 will be £20,435. For 1895-96 the estimated expenditure was £13,900. The Committee estimated the receipts for 1896-97 at £27,925.

The Lighting Committee has resolved to light Candlemaker Row by electricity.

Electric Lighting of Soap Works.—Messrs. Isdale and M'Callum have just had a private installation laid down at their Caledonian Soap Works, Paisley. An "Oldham" type dynamo supplies current to three 1,000 C.P. arc lamps and 30 incandescents, which are used for lighting the yard, offices, private rooms and warehouses. Messrs. Robertson & Co., of Paisley, carried out the work.

Glasgow.—The deputation, who have inspected the electric lighting of other towns, are unanimously of opinion that for the purpose of giving the most effective illumination, and diffusing the light over the largest area without shadow, the overhanging lamp, which has been adopted in Brighton, is the best. In Glasgow, however, some modification might be made in the length of the projecting arms attached to the pillars. They are also of opinion that all the arc lamps erected, or to be erected, should be run during the usual hours of gas lighting system, and not be switched off and turned to incandescent lamps at certain fixed hours, as done at Portsmouth. They did not think that would be desirable. They ask the Council to remit the matter back to the special committee for further consideration.

Helensburgh.—The Police Commission has appointed a committee to consider the question of electrically lighting the borough.

Lambeth.—The Special Committee appointed to consider the question of electric lighting is stated to have resolved to surrender the provisional order to Messrs. Julius Sax and Co., on the ground that they offer the most favourable terms to the parish. They undertake not to charge more than 6d. per unit, and to combine a refuse destructor with the scheme. They also offer to supply current for, and maintain free of charge 25 arc lamps in the compulsory streets. Messrs. Manlove, Alliott and Company would be responsible for the destructor portion of the undertaking, while Mr. R. W. Weekes, A.M.I.C.E., A.I.E.E., would have charge of the electric lighting proper. There is some discussion in Lambeth as to whether the dust-destructor shall be adopted in conjunction with the lighting scheme of Mr. Sax; but in the event of its being rejected, Mr. Sax reserves to himself the right to charge 6½d. per unit for the electricity supplied to consumers. An alderman is stated to have a counter-proposal to offer to the vestry, which would, if adopted, avoid a big outlay on plant, while at the same time retaining the order in the hands of the ratepayers. Upon all these subjects we shall doubtless hear plenty in due time on the floor of the vestry hall.

Llandudno.—The District Council last Friday considered schemes for the disposal of the town refuse and the introduction of the electric light. On the latter subject, Mr. A. H. Preece estimated that for £28,000 an electricity supply station could be constructed, which would be sufficient for the lighting of the town, the working of a refuse destructor, and furnishing power for an electric tramway. The question is to be discussed at a special meeting.

Lynton.—The Electric Light Company, to meet the increasing demand, are constructing a reservoir on Summerhouse Hill for the purpose of providing a better water supply for their machinery. A trench up the side of the hill to contain the pipes is now being excavated.

Manchester.—The minutes of the Gas Committee, which were adopted by the Council last week, included a recommendation that £1,600 be paid to the Westinghouse Electric Company, Limited, in full discharge of all claims for royalty, present and future, in connection with the three-wire and five-wire systems in use in connection with the electric installation in Manchester. Of the five-wire system, it was explained, Manchester was one of the largest users, and the system has proved exceedingly successful, and had resulted in the making of large profits. The opinion was expressed that the arrangement with the company—made subject to the condition that the Corporation should not oppose the application for an extension of the life of the company's patents—would be advantageous to the Corporation.

Newington.—The opposition at the Board of Trade inquiry which was concluded last week was very considerable and vigorous. Major Cardew will present his report to the Board of Trade in due course.

Paddington.—The vestry is endeavouring to obtain a reduction in the unit price charged by the Metropolitan Electric Supply Company. The present price is 7d., and they want it reduced to 6d.

Padstow.—The inauguration of the electric light installation at Mevagissey has led to the question of lighting the streets of Padstow by electricity being brought up at the District Council meeting by a member, who considers that if the Council adopts electricity and provides its own plant economics in the lighting bill will be effected.

Tunbridge Wells.—The arrangements in connection with the electric lighting extensions to the western suburbs of the borough are progressing satisfactorily.

Tighnabruaich.—This is stated to be the first Clyde resort to adopt electric lighting. The inauguration of the system took place last Saturday evening. The cost of the installation (£400 or £500) has been borne by Mr. Samuel Miller. The residents have undertaken to contribute £35 per annum towards the lighting. The generating plant is situated at the offices of the Mansion House, and comprises a dynamo and an 8 H.P. gas engine. Thirty 25-C.P. lamps are erected for lighting the public roads and the pier. Current is conveyed by means of naked overhead wires. The work has been carried out by Messrs. A. MacLellan, of Glasgow.

Trinidad.—The electric lighting of Port of Spain, Trinidad, W.I., does not seem to be in the right hands. We learn from a correspondent that the lighting powers are owned by a local company, and that their engineers have had to discard four engines as "rubbish," and order new ones. The street lighting of this town of 45,000 inhabitants comprises at present 100 arc lamps with clear glass globes, supposed to be each of 1,200 candle-power. Our correspondent asserts that the lamps do not burn well, and that it is possible to look close at the most brilliant of them ("for some are almost out") as long as you like with the naked eye, from the foot of the lamp-post. Of course, the base of an ordinary arc lamp is not the best position from which to estimate its illuminating power, but still things do not seem to be as they should. It would be interesting to know the types of engine and lamp which have given such unsatisfactory results; but probably the failure of the lamps is the fault of the engines.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Blackburn Tramways.—The Blackburn Corporation Tramways Company, Limited, have forwarded to the Council a letter stating that they have come to the conclusion that electricity would cost more than the present system, and that it is better to make no change in the method of working at present.

Bray Proposed Electric Tramway.—The Town Commissioners are to receive a deputation regarding proposals to erect a promenade pier and lay an electric tramway along it.

Claims against the Central London Railway.—During the past week several claims against this company for compensation for compulsory acquirement of premises have been considered in London.

Mr. G. A. Wilkinson, the arbitrator, has issued his awards in the arbitrations, Doree *v.* Central London Railway, and Leadham *v.* same, for £2,469 and £2,500 respectively. The claim in the former case, in respect of displacement from the portion of 84, Newgate Street, occupied by the claimant as an art needlework manufacturer, was for £9,739 7s.; and that in the latter, in respect of displacement from another portion of the same premises, was for £10,811 5s. 5d.

The case of the Kensington Woodhouse Park Syndicate, Limited, *v.* the Company, has been before Mr. Under-Sheriff Burchell and a special jury in London. This was a claim made by the Woodhouse Park Syndicate, Shepherd's Bush, for the sum of £32,790 as compensation for the compulsory acquirement of the park and estate, covering an area of ten acres, by the Central London Railway Company, for the purpose of constructing a terminal and generating station in connection with their line from the City to Shepherd's Bush.

Electric Traction in Egypt.—Work is well in hand in connection with the construction of the electric tramways at Cairo, the concession for which is held by a Belgian Company. Part of the plant has already arrived, and it is expected that the line will be so far completed as to allow the first section to be opened for traffic in July next.

Leeds Tramways.—At the last City Council meeting a member asked for some explanation as to the estimated cost of the proposed electrical tramway, and how long it would take to complete. Several members thought the 5 per cent. commission to be given to Dr. Hopkinson on an expenditure up to £40,000, excessive.

TELEGRAPH AND TELEPHONE NOTES.

Communication with India and the East.—We notice that on Monday last the Indo-European line was interrupted in the neighbourhood of Tiflis. This, as our readers are aware, is one of the "alternative routes," on which we have to rely for communication with the Colonies, pending the laying of the Pacific cable.

Fiji Telegraphs.—The *Colonies and Indies* says: They are to have a telegraph line in Fiji after all, the Colonial Sugar Refining Company and the Union Steamship Company of New Zealand having taken the matter up, with a view to connecting Suva with the Rewa and Ba districts by wire. The line will be carried from Suva along the coast to the mouth of the Rewa, and then through the plantation country, and probably it will be carried round by way of Raki-Raki, on to the Ba River. Arrangements will also be made for the line to touch at Na Darivatu, the Government Sanatorium in the Colo Mountains.

Interruption.—Telegraphic communication with Jersey was reported early in the week to be interrupted.

Telegraphic Communication in Scotland.—A sum of £1,000 has been placed on the Highlands and Islands (Public Works) estimate for 1896-7, for purposes of telegraphic extension in connection with the fishing industry in the Highlands. In Dumfriesshire, the Langholm District Committee is agitating for an extension of the telegraph from Langholm to the outlying pastoral parishes of Westerkirk and Eskdalemuir, a distance of about 15 miles.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Brest-St. Pierre (1869, Anglo)	April 6th, 1895 ...	...
" " (P.Q.) ...	June 24th, 1895 ...	...
Brest-Penzance (P.Q.) ...	.. ...	...
Puerto Plata-Martinique ...	Dec. 19th, 1895 ...	...
Assab-Massowah. Telegrams between these places are forwarded by special boat ...	March 29th, 1896 ...	...
Landlines.		
Communication with Matagalpa Provinces of Leon and Chinandega ...	Feb. 26th, 1896 ...	...
Trans-Continental line beyond Mazol (Mashonaland) Telegrams for Tohikwawa and Blantyre cannot be accepted.	March 12th, 1896 ...	...
Saigon-Bangkok	April 3rd, 1896 ...	April 5th, 1896
Communication with Gwelo, Salisbury, Fontesvilla and Beira, in South Africa.	April 3rd, 1896 ...	April 7th, 1896
Indo-European line between Soukhoum Kale and Tiflis.	April 6th, 1896 ...	April 6th, 1896

April 3.—Berne notifies secret language for Madagascar allowed.

The Hawaiian Cable Bill.—A Washington despatch states that the majority of the Senate Committee on Foreign Relations has accepted the Hawaiian Cable Bill, but failed to agree on the report, as they were divided as to which of the two companies should secure the contract.

The Pacific Cable.—From a *Times* telegram, dated from Ottawa, we learn that Mr. Chamberlain has informed the Government that if the Canadian delegates to the Colonial Office Conference on the Pacific cable question leave here the last week in April they will be in time to be present at the opening of the Conference. This date will suit the Canadian Commissioners admirably, as Parliament concludes its labours on April 24th, thus enabling Sir Mackenzie Bowell to go to England. Mr. Sandford Fleming will be his co-delegate. Australasia, we understand, will be represented by Sir Saul Samuel (Agent-General for New South Wales), and the Hon. Duncan Gillies (Agent-General for Victoria), both of whom are now in England, and who were appointed to act as Commissioners by the Conference recently held in Sydney. An important part of the in-

struction given to the Australian representatives is that they should consult with the other Agents-General in England in matters concerning the Pacific cable project. This places the Agent-General for Tasmania (Sir Robert Herbert) in a very delicate position, as he is a director of the Eastern and South African Telegraph Company (which is practically owned by the Eastern Telegraph Company). It is obvious that these companies have every interest in opposing by every means in their power the realisation of the Pacific cable scheme, which, undoubtedly, will prove a serious competitor. Sir Robert Herbert is also a director in one of the large cable manufacturing companies (the Telegraph Construction and Maintenance Company), and thus, although the benefit of his long experience in the Colonial Office would be a serious loss to the Conference, it would appear that under the above-mentioned circumstances he could not with propriety take any part in the deliberations of the Conference, which is about to be held in London, without severing his connection with the companies above-mentioned.

CONTRACTS OPEN AND CLOSED.

OPEN.

Austria.—June 1st. The municipal authorities of Prague are inviting tenders for the erection and equipment of a municipal electricity generating station in the town for electric lighting, power, and tramway traction purposes. Tenders are to be directed to the Stadrath der Haupt, Stadt Prague, Prague, Austria, from whom full particulars may be obtained.

Austria.—April 15th. Tenders are invited for the supply of 2,246 cast-iron pipes varying from 100 to 400 mm. in diameter, required during the present year for the extension of the telephonic system in Vienna. Tenders are to be directed to the K. K. Postund Telegraph Direction, Abtherlung XIII., Vienna.

Bedford.—April 21st. The Urban Sanitary Authority invites tenders for the supply of vulcanised rubber cables. For further details see our "Official Notices."

Bedford.—April 21st. The Urban Sanitary Authority is inviting tenders for the construction in various positions in the borough of five underground sub-stations. Particulars obtainable at the Engineer's Office, Electricity Works, Bedford.

Bray.—April 20th. Tenders are invited by the Commissioners for supply of cables, carbons, house wires, &c., for a period of 12 months. For further details, see our "Official Notices."

County Antrim.—May 1st. The Commissioners for the control of Lunatic Asylums invite tenders for the supply and erection of an electrical installation at County Antrim Lunatic Asylum.

Derby.—April 13th. The Corporation wants tenders for the supply and laying of low tension cables and junction boxes in the borough. For further details see our "Official Notices."

Eston.—May 1st. The District Council invites schemes for lighting the district by electricity, such schemes to embrace (*a*) plan and estimated cost; (*b*) annual working cost and maintenance. Particulars from the District Surveyor, Grangetown, Yorkshire.

Hampstead.—April 27th. The Vestry invites tenders for the supply and erection of a 300 k.w. steam alternator, switchboard, steam and exhaust pipes, &c., for the Stone-yard Central Station. For further details, see our "Official Notices."

Lima.—June 1st. The Municipal Council is inviting tenders for the establishment and working of the electric lighting in the squares and streets of the city, with power to work the private supply under a 20 years' contract. Particulars to be obtained at the Peruvian Legation, 13, Comeragh Road, West Kensington, W.

Peru.—June 1st. The Municipal Authorities of Lima, Peru, are inviting tenders for the concession for the electric lighting of the city. Tenders are to be directed to La Legation de Perou, 8, Avenue Hoche, Paris, from whom particulars may be obtained.

Rathmines.—April 20th. Tenders wanted for the electric lighting of the new Town Hall and offices for the Commissioners. Installation to consist of 250 lights, engine and dynamo. Also telephone and electric bell installations. Details at the office of the Secretary, Town Hall, Rathmines, Ireland.

Shoreditch.—April 14th. The Vestry invites tenders for engines, dynamos, pumps, mains, transformers, accumulators, &c., for the generating station. Specifications, &c., from Messrs. Kincaid, Waller, and Manville, 29, Great George Street, Westminster. See our "Official Notices."

Sunderland.—April 29th. The Corporation invites tenders for an evaporative tubular surface condenser with air and circulating pumps. For further details see our "Official Notices."

CLOSED.

Rathmines.—The Commissioners have accepted the lowest tender sent in (that of Messrs. Port, Sykes & Co., at £256), for erecting a telephone system from the Town Hall to the Waterworks at Bohernabreena.

NOTES.

Copper on Snowdon.—Doubtless a certain number of sanctimonious bigots are satisfied in their own narrow minds that the recent fatality which accompanied the opening of the Snowdon Mountain Railway was a direct visitation of God upon the sinfulness of mankind in disturbing the solitude of Nature by laying the iron road from the bottom to the top of the hitherto almost inaccessible Welsh mountain. We ourselves have little sympathy with enterprises which only serve to bring the British tourist in shoals to desecrate and rob of its natural beauty any historical spot which should be looked upon as sacred and held inviolate, but when any useful purpose is to be served, we do not let sentiment stand in the way, for in these days of depression in agriculture, and foreign competition ruining the industries in which England till but lately stood first and foremost, it is desirable to turn everything to good account. Only a few months ago a cry of lament was heard from certain well-meaning, but thoughtless, individuals, who in the height of their imagination declared that the Falls of Foyers would be for ever lost to the lover of nature, because an Aluminium Company had secured rights to use the waterfall as a source of motive power for its machinery. As a matter of fact, the lover of Nature will not be the loser, and the natives of the district hail the advent of the company with the satisfaction which comes of increased prosperity. And so the Snowdon Mountain Railway may revive an industry which for over half a century has been idle. The strata in the neighbourhood of the waters of Llyn Du'r-arddu are so impregnated with copper that no fish can live there, and round the lake there are old copper workings which have been disused for more than 50 years, on account of the expense of bringing the ore down the mountain; but now that easy means of removal are at hand through the medium of the new line, it is recognised that once again there exists high up the side of Snowdon a source of traffic and profit.

The Baltimore and Ohio Electric Locomotive.—A few particulars of the running of this locomotive are given by the *Electrical Engineer*, of New York. We are told that the speed attained by No. 1 was 35, and even 40 miles per hour, with a 500 tons train. Running light up a grade of 0·8 per cent., a rate of 61 miles was made without inconvenience for a short time. A double train of 1,900 tons was started easily and gradually when the draw bar broke. Being recoupled, it was again started with stretched draw bars, and got up to a speed of 12 miles without the wheels slipping. The current recorded was then 2,200 amperes during acceleration, dropping to 1,800 when speed had been attained, the voltage being 625. This shows a draw bar pull of 63,000 lbs., all the four motors being in series. In testing the draw bar pull by means of the dynamometer car, it appears that the amplitude of the vibrations is considerably less than with steam locomotives when the torque depends on the crank angle; on a hot day, the pull up grade of 0·8 per cent. was 22 lbs. per ton. The effect of gravity being 16 lbs., the train resistance was thus 6 lbs. per ton. In winter, owing, probably, to greater stiffness of lubricants, this pull was increased 20 or 30 per cent. These tests were checked by removing part of the load, when the difference was shown to correctly correspond with the weight removed. Each ampere of current gave a pull of 28·6 lbs., and by comparing tests, the pull of the engine itself was seen to need 144 amperes. In determining the acceleration of the train, balls of dough were dropped every two seconds, and as they would stick where they fell, they marked the distance run in the interval. For the month of October, 1895, the operating expenses were 23 cents. per mile, or about equal to those of a freight locomotive on a steam line. The conductor in the tunnels had three months in which to become dirty and rusty before use. At first it leaked 21 amperes, but very soon dropped to 4 amperes, and after repeated dressings with kerosene, frequent scrapings, and the running of a brush over its length, it is now getting into better order, but two shoes in tandem are still used to render the picking up of current more certain than the still uneven surface will guarantee. For this particular tunnel service, the electrical locomotives seem to be quite a success.

Presentations.—We are informed that Mr. W. Bathurst, who has held the post of assistant engineer at the Hampstead Electric Lighting Station since the date of its opening, was last Saturday the recipient of a testimonial in the form of a leather writing case, which was subscribed for by the indoor staff. We understand that it is with great regret that the electricity department are now losing him. He is leaving for the Cape at the end of next week. The presentation was made by Mr. Egerton Sayer, engineer in charge of mains. We also learn that Mr. C. O. Bastian has lately tendered his resignation, and will be leaving Hampstead station in the course of the next fortnight.

On 2nd inst. the staff at the Edinburgh Electric Light Station presented Mr. Monkhouse, who, as we have already stated, has resigned the post of electrical engineer there, and is coming to London to practise as a consulting engineer, with a Fuller's drum slide calculator, and a complete set of Crosby's steam indicators.

Prof. W. Wilson, M.A., who has for 5½ years had charge of the electrical engineering department of the Merchant Venturers Technical College, at Bristol, was on 1st inst. presented by the pupils of the Boys' School, whom he had taken in "Applied Physics," with some handsome ornaments, and by the senior students of the College with a clock and ornamental figure, as an acknowledgment of his valuable services, and as a token of personal regard. Prof. Wilson goes to Salford as principal of the Municipal Technical School there.

The "Ampère" and the "Charente."—It is well known that these two vessels are the only ones possessed by the French Government for the laying and maintenance of submarine cables. They have just received a fresh stock of instruments and engines, that considerably increase their powers. The *Ampère*, formerly stationed at Brest, has just been ordered to Le Havre, so that this vessel may be placed in the centre of the service for which she is intended. In fact, the maintenance of the Anglo-French submarine cables had, up to the present, been in the hands of the English Government, and the conditions under which the service was carried on were very onerous. The *Ampère*, which was formerly used solely for the maintenance of the Atlantic cables, will shortly extend its service to the Channel lines, and will thus be permanently in readiness to go wherever it may be required. In this way many new employments have been found for this vessel, in meeting requirements which formerly did not exist, for the service which it fulfilled each year, being only of limited duration, enabled part of the staff to be transferred to the other cable ship, the *Charente*, which is stationed in the Mediterranean.—*L'Electricien.*

Mr. Henniker Heaton and Submarine Telegraphy.—Mr. Henniker Heaton, the apostle of postal reform and cheap telegraphy, has recently been enlightening the public on the subject of his favourite scheme—cheap submarine telegraphy—in the form of an article in a recent issue of *Cassell's Magazine*. It is a pity that Mr. Heaton does not render himself better acquainted with some of the important facts which govern telegraphic working, as he seriously damages the cause for which he works so arduously by ridiculous statements. We pass over such assertions as that "the sheathing wires of submarine cables are protected from rust by being covered with tanned hemp," except that we would remark that it betrays want of accuracy, when the latter is very important. Mr. Heaton, however, commits a most serious blunder when he states that he has seen an apparatus which will work at the rate of 400 words per minute through an Atlantic cable, the average speed being, he says, at present only 10 words, though a maximum of 45 is sometimes reached. If Mr. Heaton's arguments are to be worth anything, they must be based on established facts, and care should be taken that a thorough grasp of the subject is first obtained. Any cable expert could have made it plain that such a speed as that stated is impossible of attainment under existing conditions, and to argue for cheap submarine telegraphy on the ground that it is possible is quite absurd. Mr. Heaton surely knows, or ought to know, the difference between landline and cable working.

An Unknown Discoverer.—*Nature*, last week, published an obituary notice of a most remarkable man, one Anianus Jedlik, a Benedictine monk, who became Doctor of Philosophy in 1822, and in 1840 was appointed Professor of Natural Philosophy at the University of Pest, having for years previously taught science at Pannonhalma, Györ and Pozsony. At the time of his death, on December 12th last, he had reached the advanced age of 96. Our contemporary states that:—

Jedlik's scientific researches extended to various branches of natural philosophy, but he turned his attention principally to those connected with galvanism and electro-magnetism.

Within the sphere of these, Jedlik succeeded in making two important discoveries, which can be proved with total certainty. But these discoveries now bear the names of others, who happened to make them independently of Jedlik, and hastened to make the scientific world acquainted with them, while he merely laid them before his own pupils.

It was in the first years of his professorship—in 1827-1828—that, upon reading about electro-magnetism in the German periodicals to which he had access, he modified Schweigger's multiplier in the following manner. He put in the place of the magnetic needle an electro-magnet, and thus, with the aid of a current commutator, produced permanent rotation.

Jedlik relates, in his modest manner, that he never came upon any mention of such electro-magnetic rotatory apparatus in any of the periodicals or works with which he was acquainted, so that he could not but believe that he was their discoverer. But he kept it to himself, as he had repeatedly experienced that descriptions of apparatus constructed by him after his own original ideas, already existed elsewhere; and so he never thought of sending descriptions of the above to any of the foreign scientific periodicals of which he knew.

Jedlik's other discovery had reference to the fundamental principle of the dynamo-electric machine. In the collection of the physical department of the University of Budapest there is a machine of very primitive construction, dating, as it appears, from somewhere about the year 1860, and probably the work of some mechanician of Pest, to which are joined directions as to its use in Jedlik's own handwriting.

In the fourth point of these instructions we find clearly defined the fundamental principle of the dynamo-electric engine, which principle Werner Siemens brought before the Academy of Berlin in 1867, and according to which the magneto-electric currents of augmenting force may be developed by means of mechanical force, with the aid of the slight amount of magnetism contained in ordinary soft iron.

The topics of some of his more important treatises are as follows: "The Deflection of Beams" (1845); "The Application of the Electro-Magnet in Electro-Dynamic Rotations" (1856); "A Modification of Grove and Bunsen's Battery" (1857); "The Magneto-Motor" (1857); "Concatenation of Leyden Jars" (1863), through which peculiar modification he attained a remarkable degree of effect; "Modification of Fresnel and Pouillet's Interference Apparatus" (1865); "Tubular Electric Collectors" (1867); "Electro-magnetic Undulation Machine" (1868).

Life of Incandescent Electric Lamps.—Mr. W. M. Smith, District Locomotive Engineer, Great Southern and Western Railway, Locomotive Department, Cork, sends to *Engineering* the following record of the life of some incandescent lamps used in the engine and machine room of that railway. An alternating current is used:—

	Hours.	Maximum life. Hours.
The average life of 38 lamps was	3,471	11,005
" " 17 "	2,140	5,468
" " 9 "	5,337	17,880
" " 5 "	1,879	23,434
" " 6 "	6,747	15,517

Lamps Still in Use.

	Hours.
4 lamps which had run over	30,000
1 " "	17,600
1 " "	15,000
2 " "	10,000
4 " "	4,000
1 " "	3,400

They are all 50-volt 16-candle-power lamps. Mr. Smith says he is not aware of anything like so long a life having been obtained with a continuous current.

The Telephone Trunk Lines.—On Saturday, the 4th inst., the Post Office took over the trunk lines in the Southern District. The remainder of the lines will be worked for the present by the National Telephone Company on behalf of the Department until arrangements are complete for carrying out in its entirety the agreement sanctioned by the House of Commons. With the lines purchased from the Company, and those specially run by the Post Office, a great increase in the facilities for inter-town communication will be available.

Personal.—We are informed that Mr. W. B. Sayers has resigned the position of works' manager with Messrs. Mavor and Coulson, which he has held during the past 5½ years, and has commenced practice as consulting engineer and electrician at 189, St. Vincent Street, Glasgow.

Mr. Wm. H. Booth has resigned his appointment as managing engineer for Messrs. Le Grand & Sutcliff, artesian engineers, and has taken offices at No. 17, Shaftesbury Avenue, London, W., where he will carry on business in steam engineering, water supply, and electrical transmission of power, &c., paying special attention to artesian wells, and questions of hydrogeology and electrical power. Mr. Booth has carried out many successful undertakings for railways, breweries, manufactories, electrical stations, public institutions and country houses.

Oh! Those X Rays.—A New York exchange quotes the following lines on an X rays portrait of a lady, by Lawrence K. Russell, in *Life*:—

She is so tall, so slender; and her bones—
Those frail phosphates, those carbonates of lime—
Are well produced by cathode rays sublime,
By oscillations, amperes, and by ohms.
Her dorsal vertebræ are not concealed
By epidermis, but are well revealed.

Around her ribs, those beauteous twenty-four,
Her flesh a halo makes, misty in line,
Her noseless, eyeless face looks into mine,
And I but whisper, "Sweetheart, Je t'adore."
Her white and gleaming teeth at me do laugh.
Ah! lovely, cruel, sweet cathodograph!

Rev'ewing Reviews.—A writer in a contemporary, referring to the Electrical Review states that "Mr. C. Brown sends a very indignant letter, complaining of the treatment his former letter on superheating (which was not intended for publication) has received from the Electrical Review." We merely wish to say that Mr. Brown did nothing of the sort, his indignation being directed against the *Engineer*, to whom his former letter was sent. It seems that *conversaziones* held on Saturday evenings are not conducive to accurate work on the following day.

The New Photography.—At the Nottingham University College a lecture was delivered the other day by Professor Heaton, M.A., on "The New Photography." A number of slides of objects photographed by Mr. A. H. Simpson in the Physical laboratory were shown on the screen.

From the Electric Photo-printing Company, of Nottingham, we have received a book of specimens as shown at the above lecture. These include several photographs of hands, a mouse, a rat, a frog, and part of a man's foot. The prints are capital.

London-Paris Telephone Service.—It is stated that the telephone service betweeen London and Paris has been so successful, that the authorities are about to lay a second cable across the Channel, to meet the increasing demands for the use of the wires. The new line is to be laid from Lydden Spout, about two miles to the west of Dover. It is probable that when the cable is completed, Manchester and Liverpool, and some other large centres, will be directly connected.

Obituary.—The death is announced of Count Mattei at the advanced age of 86 years. After a brief political career the Count retired into private life, and devoted himself chiefly to the study of medicine. He will doubtless be remembered by many readers in connection with the cure all "liquid electricities." It is stated that "the secret" of this and his other "remedies" is left to his adopted son.

Great Electric Tramway Scheme.—A very extensive scheme is on foot, which is expected to revolutionise the tramway service of London. A powerful syndicate offers to take a lease of the existing lines from the County Council, in order to consolidate the whole of the service, to make extensions and connections, and to apply electric traction throughout.

All Moonshine.—It is but rarely that we have any feeling in common with one of our contemporaries, but we are thoroughly in accordance with the writer of three pages of more or less captious burlesque, entitled "Cosmic Romance," which appears in what may be termed its holiday number.

The Magnetic Needle.—Newspapers state that an interesting scientific investigation is shortly to be undertaken by the French *savant*, M. Moureau, at the invitation of the Imperial Russian Geographical Society. Some 10 years ago a Russian professor made the discovery that in the district between Kursk and Kharkoff the magnetic needle, instead of pointing approximately north, points to other divisions of the card, such as east or west. Apparently the matter was not then followed up, but it will doubtless be elucidated ere long by M. Moureau. Had the Russian professor's needle become demagnetised? This seems to be the first point requiring elucidation. Or had he tumbled across beds of magnetic ore?

The Northern Society of Electrical Engineers.—At the meeting on Monday, April 13th, there will be a lecture and demonstration of the New Photography with Lantern Views, by Mr. C. M. Dorman, member. After the lecture the members of the Society will visit the Manchester Corporation Battery Station, on the invitation of Mr. C. H. Wordingham.

Death from a Faulty Transformer.—At the inquest on the death of W. S. Goff, who was recently killed by electric shock at Woburn, Mass., it was shown that death was due to a contact between the primary and secondary of a transformer. In this case, says a New York exchange, a ground necessarily existed also on the line.

The Technical Journalist.—We are glad to note that the editor of a contemporary holds that a technical journalist is bound to be omniscient, and that, without science, his omniscience is apt to be questioned when he writes of technical matters. If he would only lay this to heart, we might be spared many a weekly infliction.

The Institution of Electrical Engineers.—On Thursday, April 16th, 1896, the paper on "Telephone Exchanges and their Working," by Dane Sinclair, member, will be discussed.

NEW COMPANY REGISTERED.

Ernest F. May, Limited (47,408).—This company was registered on March 30th with a capital of £5,000 in £1 shares, to acquire and carry on the business of a manufacturing electrical engineer and contractor, carried on by E. F. May at 9, Pratt Mews, Pratt Street, Camden Town, N.W., and to adopt a certain agreement. The subscribers (with one share each) are:—P. H. Bastie, 47, Camden Park Road, N.W., electrical engineer; H. Gorton, 80, Parkhurst Road, N., electrical engineer; F. B. Gardiner, 84, Malden Road, N.W., electrical engineer; H. Barton, 92, Ballance Road, Homerton, electrical engineer; J. Dyer, 12, Manor Road, N., gentleman; E. Dyer, 12, Manor Road, N.; C. G. Box, 22, Harvest Road, Holloway, accountant. The number of directors is not to be less than three, nor more than five; the subscribers are to appoint the first; qualification, £100; remuneration, £25 each per annum. Registered by Martin & Nicholson, 29, Queen Street, E.C.

CITY NOTES.

The Phosphor Bronze Company, Limited.

The directors' report submitted at the annual general meeting on Friday, March 27th, congratulates the shareholders on the improvement in the position of the company as compared with that of the previous three years. The net trading profit amounts to £2,097 0s. 2d., which, after provision is made for debenture interest, all fixed charges, &c., leaves a balance of £93 10s. 5d., which it is recommended should be applied to forming a nucleus for a sinking fund for the redemption of debentures and the premium thereon. The company still hold the 100 shares of the nominal value of £300, the proceeds of which, when sold, will go to the credit of profit and loss in part recovery of the loss sustained through the Birmingham frauds. The depression in trade during the first half of 1895 was even more marked than in 1894, but in the second half a very great improvement took place; this has since been fully maintained. Notwithstanding the increasing severity of competition, the directors have good reasons for anticipating a career of renewed prosperity for the company; and now that most of the material obstacles to its progress have been removed, they fully believe that the company will soon be in a position to resume the payment of dividends. The petition for the reduction in the nominal capital from £150,000 to £90,000, by altering the nominal value of each share from £5 to £3, having been granted by the Court, resulted in the diminution of £31,420 in the paid up capital of the company; this sum was appropriated to the extinction of the debit balance on profit and loss account, and to the reduction by £22,095 of the goodwill and patents' account, which now stands at £21,580. As the Court declined to sanction the proposed additions to, and alterations in, the company's memorandum of association unless the title of the company was materially changed, the

directors, having regard to the importance of retaining intact an old established trade name, declined to comply with this condition and withdrew the petition, thus leaving the subject still in abeyance. Considerable alterations and additions have during the year been made to the plant at the mills—new boilers and rolls, a high class engine, shearing and other machines have been contracted for. The directors notify the withdrawal from the board of their esteemed colleague, M. Lazare Weiller, who will remain a large shareholder. Mr. Richard Gamble has also retired from the board.

At the meeting the report and accounts were adopted. Mr. Francis W. C. Cumming was re-elected a director, and Mr. R. Payne, F.C.A., was reappointed auditor.

Oswestry Electric Lighting and Power Company, Limited.

The annual meeting of shareholders of the Oswestry Electric Lighting and Power Company, Limited, was held at the Harlech Castle, Oswestry, on Friday, 27th ult. Mr. A. Wynne Corrie presided. The report to the end of December, 1895, showed that the balance of profit and loss account is £33 6s. 1d., which the directors propose to carry forward. Up to the present date the directors have received and accepted 24 applications for the supply of the current, including three contracts with the Corporation of Oswestry. Mains have been laid in the streets included in the compulsory area, the supply to which will be shortly completed, and the directors are about to lay mains in other roads. With the purpose of still further popularising the use of the electric light, the directors have decided to reduce, as from January 1st, 1896, the maximum price to 6d. per unit, for payment within one month from due date. All current used in any half-year beyond the amount which would be consumed during 635 hours (two hours per day throughout the half-year) at the highest rate of actual consumption at any moment during the half-year, will be charged for at the rate of 3½d. per unit. With a view to the further development of profitable operation, the directors invite applications for a limited additional number of ordinary shares.

The Chairman proposed that the report and statement of accounts be adopted. He thought it must be some satisfaction to the shareholders to find that a small company like that, in its first effort, could show a balance to the good. It was, of course, only a small balance, but in his opinion it was really more than could be anticipated, because it only represented profits from October to December. When they began to run in October there were naturally very few consumers, and the demand was small, but by a diagram they saw before them they would see there had been a very gradual but a very real and substantial increase from October to the end of the year. He was glad to say that so far that demand steadily went on. The fact that they had that, and that they could as a new company, instead of having a deficit, as many such companies had, show a balance to the good, he thought showed that the directors had done their best to economise in every possible way. He saw no reason why, if the demand continued and if they were fortunate, at the next annual meeting they should not declare a dividend. It was the intention of the directors to put down such plant as would enable them to cope with any increased demand. They had had applications from private houses, and had decided to extend their mains. He believed once it was taken in private houses, and its advantages were found to be so very great, there would be a rush for it. He was also pleased to know that those who were connected with the churches and chapels of the town were considering the matter of installing the light in their buildings. In regard to their accounts, the Board of Trade had sent down their auditor, who had gone through the books, and had reported that everything was perfectly right and in order.

Mr. R. Lloyd seconded the motion.

Mr. Williams asked a question as to the £54 6s. 6d. in the accounts as the cost of the provisional order.

The Chairman said it seemed an extraordinary and extortionate thing that a small company like theirs should have to spend over £500 to get an order to permit them to spend their own money. There seemed to be no difference made between a company of a million pounds capital, and one of a thousand pounds capital. Some part of that sum, however, would have been saved if the Corporation of Oswestry had not opposed the order, an opposition for which they got nothing.

Willans and Robinson, Limited.

The ordinary general meeting was held on Wednesday at Cannon Street Hotel. Mr. Mark Robinson, who presided, remarked that the business of their second year had surpassed that of the prosperous first year of the company, and now in the beginning of their third year the volume of their orders had risen to figures which were nothing less than astonishing. When the report was written they could only say that in less than three months the orders had reached 22,000 H.P. They could now say that in three months they actually reached 24,400 H.P. And not only did their business increase, but its profitableness increased also. It had been the steady object of the directors to promote the demand for the Willans engine in much larger sizes, but the development of the business in really large engines awaited the completion of the new works at Rugby. The average of the engines ordered in the first quarter of 1896 was not less than 263 H.P. and among their recent orders was one for four engines of 1,100 H.P. each, and others of about 700 H.P. for driving mills on the Continent. After giving particulars of the new works which are being constructed for the company at Rugby, at a cost, including equipment, of upwards of £80,000, he moved the adoption of the report.

Eastern Extension, Australasia, and China Telegraph Company, Limited.—The numbers of 5 per cent. Australian Government subsidy debentures, drawn by lot on April 1st, which will be paid off at par on July 1st next at Messrs. Barclay, Bevan and Co., 54, Lombard Street, E.C., are advertised. After that date interest on them will cease.

Submarine Cables Trust.—On and after 15th inst. the sum of £2, on account of the coupon due April 15th, 1896, will be paid by Messrs. Glyn, Mills and Co., of 67, Lombard Street, between the hours of 10 am. and 2 p.m. The coupons should be left for examination four clear days before payment.

CONTINENTAL NOTES.

Acetylene.—Francois d'Humilly de Cherilly and Eugene de Boismenu, both of Paris, have formed themselves into a company for lighting with acetylene gas. The company is to last for three years. Its registered office is at 36, Boulevard du Temple, Paris, and its capital is 8,000 francs.

Souchier & Co.—The object of this company is to carry out a concession for the supply of appliances for lighting, and for the transmission of power by means of electricity, in the town of Muy (Var). Its office is at 4, Rue des Recollettes, Marseilles, its duration is 25 years, and its capital 86,000 francs in shares.

Tramway Company of Fontainebleau.—The object of this company is all commercial or financial operations belonging to the industry of tramlines at Fontainebleau and its district, to mechanical, and especially to electrical traction. The duration of the undertaking is fixed at 75 years, and its provisional office is 53, Rue des Dames. Its capital is 600,000 francs, in 6,000 shares of 100 francs each. The company will be administered by a board of not more than seven, or fewer than four members.

The Electric Tramway Company of Clermont-Ferrand has secured an available profit of 80,077.01 francs. Hence the board proposes to declare a dividend of 25 francs on the 2,800 old shares, or a total of 70,000.00 francs, carrying over the balance of 10,077.01 francs to the reserve. It will be perceived that the gross gain on the operations of the company has increased from 138,014.04 francs in 1894, to 149,941 in 1895, showing an increase of 11,937.13 francs.

Electric Tramway Company of Dijon.—The general meeting of the Electric Tramway Company of Dijon took place on February 27th. The available profit was declared to be 96,410.134 francs, and a dividend of 25 francs per share was announced. The kilometre run has cost the company, as a mean, 0.262 franc, and has yielded a mean receipt of 0.4938 franc.

The Company of Niel Motors has increased its capital from 600,000 to 700,000 francs.

French Company for Working the Thomson-Houston Procedures.—This company is about to issue 20,000 debentures of 500 francs each, representing a total of 10,000,000 francs.

G. & H. B. de la Mathe.—This company is dissolved by the withdrawal of the last-named partner. It will continue the manufacture and establishment of electric cables, and the general employment of caoutchouc and gutta-percha, and will have its offices at the Gravelle works in Joinville.

Hungarian Electrical Company.—This company, with a capital of 5,000,000 francs, has realised last year a gain of 508,357 francs, to which must be added the sum of 70,917 francs from the issue of 10,000 new shares. The directors propose a dividend of 5·5 per cent.

Ganz & Co.—The working for 1895 shows a profit of 1,400,106 francs. It is proposed to distribute a dividend of 200 francs per share of 800 francs. The board has concluded an agreement with Loewe & Co., of Berlin, and is about to erect new works in the Ofen quarter of Buda Pesth. To this end 1,200 new shares will be issued.

Pollak Accumulator Works at Frankfurt.—The returns for 1895 have been 53,000 francs, as against 42,000 francs for the foregoing year. The production of the works has been doubled, and if the sale price has been reduced the outlay for labour has been equally lowered.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending April 5th, 1896, were £815; week ending April 7th, 1895, £935; decrease, £120; total receipts for half-year, 1896, £13,471; corresponding period, 1896, £13,583; decrease, £112.

The Direct Spanish Telegraph Company. The estimated receipts for the month of March, 1896, £3,123.

The Great Northern Telegraph Company. The traffic receipts in March, 1896, were £22,400; 1st January to 31st March, 1896, £66,400; corresponding months, 1895, £68,000; corresponding months, 1894, £63,000.

Th Liverpool Overhead Railway Company. The receipts for the week ending April 5th, 1896, amounted to £1,256; corresponding week last year, £1,024; increase, £232.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending April 3rd, 1896, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company Limited, were £2,180.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME,	Stock or Share. ‡	Dividends for the last three years. 1893.	1894.	1895.	Closing Quotation, March 31st.	Closing Quotation April 8th.	Business done during week ended April 8th, 1896. Highest.	Lowest
173,400£	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	4 %	4 %	100 —104	100 —104	...	...
25,000	Amazon Telegraph, Limited, shares...	10	...	...	...	10½— 11	10½— 11	...	...
1,012,880£	Anglo-American Teleg., Ltd.	Stock	£2 11s.	£2 2s.	£2 9s.	47 — 49	48 — 50	...	...
2,993,560£	Do. do. 6 % Pref.	Stock	£5 2s.	£4 4s.	£4 18s.	90 — 91	91½— 92½	91⅞	90⅝
2,993,560£	Do. do. Defd.	Stock	...	...	...	8 — 8½	9½— 10	9⅞	8 7/16
130,000	Brazilian Submarine Teleg., Ltd.	10	6½% § §	7 %	...	14¼— 14⅝	14¼— 14⅝	14⅝	14⅜
75,000£	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	5 %	...	112 —116	112 —116	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	... § §	2½%	...	3 — 3⅛	3 — 3⅛	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	160 —170	160 —170	...	...
224,850	Consolidated Telap. Const. and Main., Ltd. ...	10/-	2 % § §	1½%	...	3/16— 3/16	1/16— 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	12½— 13½	12½— 13⅝	13½	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	20½— 21½	20½— 21½	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 10½	10 — 10½	...	...
30,000£	Do. do. 4½ % Debs Nos. 1 to 6,000 ...	50	...	4½%	4½%	106 —109 %	106 —109 %	...	...
60,710	Direct United States Cable, Ltd.	20	2⅝% § §	2 %	...	9½— 9⅝	9½— 10	9 11/16	9⅛
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½% § § § §	6½%	...	17 — 17½	17 — 17½	17 7/16	17¼
70,000	Do. 6 % Cum. Pref.	10	6 % § §	6 %	...	18 — 18½	18 — 18½	18 1/16	...
102,100£	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	...	105 —108	105 —108	...	...
1,297,837£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	...	129 —132	130 —133	132	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	...	17⅜— 18½	17⅜— 18½	18½	18⅛
54,100£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	...	101 —105	101 —105	...	...
194,300£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	...	102 —105	102 —105	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	...	128 —131	128 —131	128⅜	...
80,600£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	...	101 —105	101 —105	...	...
107,600£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	...	102 —105	102 —105	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	...	105 —108	105 —108	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	...	112 —115 %	112 —115%	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4⅜% § §	4½%	...	10½— 10⅝	10½— 10⅝	10 11/16	10½
180,042	Do. do. 6 % Pref.	10	6 % § §	6 %	...	16¾— 17¼	16¾— 17¼	17⅛	17
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜%	8⅜%	...	22¾— 23½	22¾— 23½	23⅛	...
180,000£	Do. do. do. 5 % Debs.	100	5 %	5 %	...	104 —107	104 —107	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	...	48 — 51	48 — 51	...	...
100,000£	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6 %	...	107 —110	107 —110	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	4 %	...	2 — 2½	2 — 2½	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 % § §	5 %	5½%	6⅜— 7	6⅜— 7	7	6⅞
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	16 — 18	16 — 18	17¾	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	16½— 17½	16½— 17½	17⅛	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6⅜— 6⅝	6⅜— 6⅝	6⅝	6 11/16
1,100,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	106 —109	106 —109	106¾	...
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	4½%	...	2/16— 1 1/16	2/16— 1 1/16	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	...	108 —111	108 — 111	...	...
11,839	Reuter's Ltd.	8	0 %	*nil*	...	5 — 6	5 — 6	5	...
3,381	Submarine Cables Trust	Cert.	...	...	...	134 —139	134 —139	136	...
58,000	United River Plate Teleph., Ltd.	5	...	3 %	...	3½— 4	3½— 4	...	...
146,733£	Do. do. 5 % Debs.	Stock	5 %	5 %	...	96 —101	96 —101	98½	98
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	*nil*	*nil*	...	5½— 6½	5½— 6½	...	...
238,300£	Do. do. do. 5 % Debs.	100	5 %	5 %	...	101 —104	101 —104	...	...
30,000	West Coast of America Teleg., Ltd.	10	*nil*	*nil*	...	1 — 2	1 — 2	...	...
150,000£	Do. do. do. 8 % Debs., repay. 1902	100	8 %	8 %	...	95 — 100	95 —100	...	...
64,248	Western and Brazilian Teleg., Ltd.	15	2½%	3 %	...	8½— 9	8½— 9	8⅞	...
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	...	6¼— 6⅝	6¼— 6⅝	6 7/16	...
33,129	Do. do. do. Def. Ord.	7½	...	1 %	...	2¼— 2⅝	2¼— 2⅝	...	...
165,200£	Do. do. do. 6 % Debs. "A," 1880 Red.	100	6 %	6 %	...	103 —107	103 —107	...	...
206,400£	Do. do. do. do "B," do.	100	6 %	6 %	...	103 —107	103 —107	...	...
38,321	West India and Panama Teleg., Ltd.	10	⅞%	1½%	...	1 — 1¼	1 — 1½	1⅛	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	...	10⅜— 11¼	10⅜— 11¼	...	...
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	...	9 — 10	9 — 10	...	...
80,000£	Do. do. 5 % Debs. No. 1 to 1,800 ...	100	5 %	5 %	...	108 —111	108 —111	...	...
1,777,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7 %	...	113 —118	113 —118	...	...
164,300£	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	...	102 —106 xd	102 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	4½%	4½%	5 %	7¼— 7⅜	7¼— 7⅜	7⅜	...
10,277	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	5 %	5 %	5 %	7½— 8	7½— 8	7 13/16	...
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	...	...	4 %	116 —119	116 —119	117¾	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	5 %	5 %	14½— 15½	14½— 15½	...	...
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	16 — 17	16 — 17	16⅝	16½
300,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	134 —138	134 —138	...	...
22,475	County of London and Brush Prov. Elec. Ligtg., Ltd., Ord. 1—22,475	10	...	...	...	8 — 9	8 — 9	...	...
10,000	Do. do. do. 6% Pref., £8 pd., 40,001—50,000	10	...	...	...	12½— 13½	12½— 13½	...	...
50,000	†Liverpool Electric Supply, all paid	5	5 %	5½%	...	7⅞— 7 7/16 xd	7⅞— 7⅞	...	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	2½%	3 %	...	13 — 13½	12¾— 13¼	13¼	13⅛
150,000£	Do. 4½% first mortgage debenture stock	...	4½%	4½%	...	118 —120	118 —120	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	1 %	2 %	8¾— 9½	8¾— 9½	...	...
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	4½%	6½%	7½%	9¾— 10¼	9¾— 10¼	...	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9¾— 10¼	9¾— 10¼	10⅛	...
67,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	4 %	5 %	7 %	9½— 10	9¾— 10¼	10	9 15/16

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. § Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1896.	1894.	1895.	Closing Quotation, March 31st.	Closing Quotation, April 8th.	Business done during week ended April 8th, 1896. Highest.	Lowest.
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000	3	5 %	2½%	...	1⅛ — 1⅜	1⅛ — 1⅜	...	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	6 %	3 %	...	1⅝ — 1⅞	1⅝ — 1⅞	...	...
125,000*l*	Do. do. 4½ % Perp. Deb. Stock.... ...	Stock	4½%	4½%	...	110 —113	110 —113	...	...
830,000*l*	City and South London Railway	Stock	1¼%	1¼%	1 3/16%	40 — 42	40 — 42	41	...
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	3 %	*nil*	...	2¼ - 2⅜	2¼ — 2⅜	...	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	7 %	5 %	...	1¼ — 1⅜	1¼ — 1⅜	1⅜	...
17,139	Do. do. do. "A" Shares 01—017,139	5	7 %	5 %	...	3 — 4 xd	3 — 4	...	...
100,000	Do. do. do. 4½% Deb. Stock Red. ...	Stock	...	4½%	...	104 —107	104 —107	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	*nil*	...	1⅛— 1⅜	1⅛— 1⅜	1¼	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	...	2¼ — 2⅜	2¼ — 2⅜	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	*nil*	...	[illegible]	[illegible]	...	...
69,385	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	*nil*	...	[illegible]	[illegible]	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil*	*nil*	...	[illegible]	[illegible]	...	...
9,600*l*	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	*nil*	*nil*	...	9⅛— 10⅛	9⅛— 10⅛	...	...
10,000	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	6 %	8 %	16¼ — 17½	16½ — 17½	17⅛	...
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	16½ — 17½	16½ — 17½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	...	...	4½%	107 —112	107 —112	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	10 %	10 %	20 — 21	20 — 21	20⅝	20½
200,000*l*	Do. do. do. 4½ % Deb., 1896	100	4½%	4½%	4½%	... ...	... ...	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	1 %	1½%	2½%	13⅞ — 14½	14 — 14½	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	16⅝ — 16⅞	16⅝ — 16⅞	..	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	20 %	15 %	38 — 41	38 — 41	39½	38½
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	102 —105	102 —105	...	...
54,000*l*	Waterloo and City Railway, Nos. 1 to 54,000, £6 paid ...	10	...	...	...	6¼ — 6⅝	8¼ — 8⅝	8⅝	8¼

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50 %. for 1890.

Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0% ; 1891—7% ; 1890—5%.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 6—6¼.

Electric Construction Corporation, 6 % Debentures, 103—106.

House-to-House Company (£5 paid), 3¼—3¼.

Do. do. 7 % Preference, of £5, 8—8½.

Do. do. 4½% Debentures of £100, 109—111.

Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 8¼—8⅜; 1st Preference Cumulative 6 %, £5 (fully paid), 7¼—7⅜.

Liverpool Electric Supply, £5 (fully paid), 7⅜—8¼.

London Electric Supply Corporation, £5 Ordinary, ⅜—½.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 6⅜—7¼.

Bank rate of discount 2 per cent. (February 22nd, 1894).

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

TELEPHONE EXCHANGES AND THEIR WORKING. By DANE SINCLAIR, Member. Paper read March 26th, 1896.

IN introducing this subject I find that, to give you anything like a clear idea of the working of telephone exchanges as they exist in this country, it will be necessary for me to refer to a few fundamental principles underlying all telephone exchange work, which, however, have been previously explained in journals, text-books, and elsewhere.

In all telephone systems there are three branches into which they may naturally be divided, viz.:—

1. The line wires connecting subscribers' offices to exchanges;
2. The instruments in subscribers' offices; and
3. The switchboards in the exchanges.

With reference to the lines, it is not my intention here to say much in regard to them; although, indeed, the lines now used for telephonic purposes differ very greatly from those formerly used for telegraphic work. It was not until the introduction of the telephone that such subjects as the static capacity and self-induction of lines received so much attention in other than submarine telegraph work. In telephone work, however, these points are of the very highest importance, and necessitate a large amount of attention. We have arrangements working on our telephone lines which, at first sight, would have appeared to the old telegraph engineer to be the worst that could possibly be devised. I have made some experiments on telephone lines, and, under certain conditions, have obtained better speaking results over a line 40 miles in length, on which there was a series of earths, or leakages, than could have been obtained with a well-insulated line. The same applies to metallic circuits, but in this case the leakage is from the outgoing wire to the return. This subject, although interesting, is, however, outside the scope of my present paper.

Broadly speaking, all the calling instruments now used in this country in subscribers' offices are those known as the magneto pattern, and there is fitted along with each a transmitter, battery, and receiver, the whole forming a complete set.

It is, however, the switchboards at the exchanges that I wish specially to bring before your notice to-night.

The diagram at fig. 1 shows the connections which, with certain modifications, are made on all kinds of switchboards. The apparatus includes a line jack and an indicator, through both of which the circuit passes either to a general earth wire, or, in the case of metallic circuits, to a return wire. I may explain that what is called a "jack" is that part of the apparatus into which the connecting plug is inserted. When any two lines are to be connected together, two of these plugs are inserted into the two jacks of the lines concerned, the plugs being connected together by a flexible conducting cord.

It is our usual practice in this country for small exchanges (of, say, under 200 lines), to make up the switchboard in sections of 50 lines. The drawing at fig. 2 shows the type of section which has been

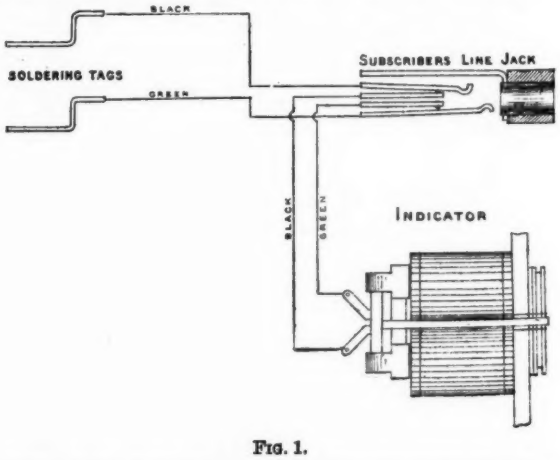


FIG. 1.

adopted by the National Telephone Company for general use in these small exchanges. In its main principles it is the same as other small standard boards, but special attention has been given to the details; facilities have been provided for connecting the line wires to the switchboard, and all the working parts have been covered so as to exclude dust as much as possible.

A further reference to fig. 1 will show that here, as before described, the line passes through the jack and indicator, and back by the return wire. Cords, similar to the one already mentioned, are fitted on a shelf, each cord having a pulley and weight to bring it back to

its proper place when out of use. A ring-off indicator is also provided, which can be put in bridge across the cord by means of the key designed for that purpose. This key is shown at fig. 3, and by it the operator can also throw her telephone into or out of circuit as required. A separate pair of keys is provided to enable the operator to ring on either of the lines she is connecting. The ringing current is, as a rule, produced by a small generator driven by an electric or other motor. These listening keys, fig. 3, and ringing keys are now universally used by the National Telephone Company, and are all of the standard patterns shown.

When a subscriber turns the handle of his generator, the shutter of his indicator in the exchange drops and shows his number. The operator then inserts one of the plugs of a double cord into the jack belonging to this line, and asks the subscriber what he wants. When this information is received, the operator inserts the plug at the other end of the cord into the jack of the line wanted, and completes the operation by turning the lever of her key, which cuts her telephone out of circuit and brings in the ring-off indicator. This indicator, as before mentioned, is now connected across the line in bridge in the case of metallic circuits, or tapped to earth in the case of single wires.

This indicator is of a special type, being wound to a resistance of 1,000 ohms, and placed inside a tube of soft iron, so as to give it large self-induction, and cause great impedance to the passage of telephone currents, which are, of course, of high frequency. The object of this indicator is to show the operator when subscribers have finished their conversation. When this signal is given to the operator, the plugs are withdrawn and everything restored to its normal condition.

As the subscribers' indicators, fig. 3, are cut out of circuit when their lines are connected as described above, they are of the ordinary type, and are wound to the resistance of 100 ohms.

In addition to the type of board already mentioned, shown at fig. 2, we have used in this country very largely, for small exchanges and for private installations, a class of switchboard known as the "single cord" board. In this pattern of board a cord and plug are provided for each line, and, as shown on the drawing (fig 4), the lines come to the outer springs of the jacks, and, without breaking, pass to the cord and terminate in the plug. In addition to this, a high-resistance indicator, of the same type as the ring-off indicator previously described, is provided for each line. To make a connection, the plug of the line of the calling subscriber is inserted into the jack of the line wanted, leaving the indicator of the first line in circuit, and, as will be seen in fig. 4, the indicator of the second line is cut out of circuit. For working this class of board, the operating instrument is provided with a plug for answering the calling subscriber and for ringing the subscriber wanted.

It will be readily understood from what has been said that, as exchanges increase in size, the switchboards become too large for the operators to be able to reach to make all the connections. In the earlier days, wires were run between the various sections of the board for the purpose of connecting the different groups of subscribers' wires together. At this point commenced the difficulties of telephone exchange work, because there was no certain method of showing to the operators in the exchange when any subscriber's line was engaged, and also because the first operator had not complete control of the connection, and consequently, it was liable to be interfered with by the second operator. In practice this became a very serious trouble. A remedy was found by our friends on the other side of the Atlantic, where they had to deal with the question of large exchanges earlier than we in this country. To overcome the difficulty, they invented what is known as the "multiple" board, the possession of patents for which must have given the owners very considerable satisfaction, as well as yielded them enormous profits.

In this connection I may mention that the multiple system was independently invented by an employé of the United Telephone Company, but subsequently to the date of the American patent.

The multiple switchboards used generally in this country are made up of the required number of sections, each containing all the apparatus necessary for 200 lines. Each section is 6 feet 6 inches in length, and is subdivided for four operators, each having 12 pairs of connecting cords, with the usual equipment of listening and ringing keys of the type shown at figs. 3. In addition to the full equipment of apparatus necessary for 200 lines, each section is also fitted with jacks, through which all the lines in the exchange pass.

On this principle the number of jacks necessary in an exchange increases in an amazing manner. For instance, an exchange with 400 subscribers' wires would require only 800 line jacks, *i.e.*, the 400 lines in the exchange would come to jacks on section No. 1, and be repeated on section No. 2; but if we consider an exchange of 5,000 subscribers' lines under similar conditions, we find that there would be 25 sections of 200 lines each. As in the case of the two sections mentioned, the line jacks would be repeated on each of the 25 sections (5,000 on each), making a total of 125,000 line jacks. In practice every exchange is provided also with junction wires to other exchanges, and many of them with trunk wires to other towns.

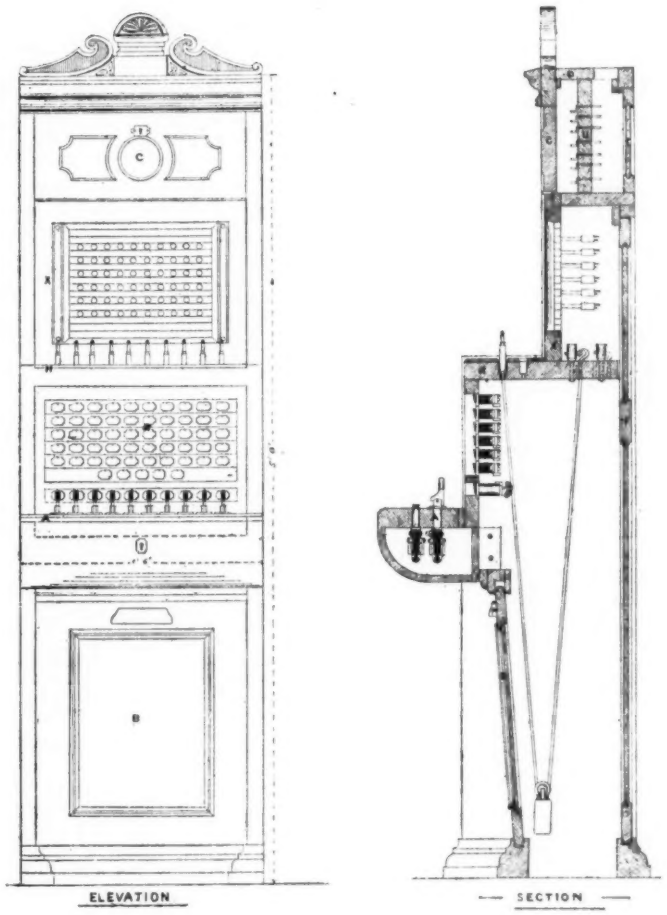


Fig. 2.

The junction wires are divided into two approximately equal groups, one carrying the outgoing, and the other the incoming traffic. To render the outgoing junctions accessible to all the operators, they are, like the subscribers' lines, multiplied on every section. Incoming junctions do not require to be multipled, but special sections are provided for working them, and these also contain a multiple of all the subscribers' lines. As it is found in practice that an operator cannot attend to more than 25 of these junction lines, each section, with four operators, will accommodate 100 junction lines.

In an exchange of 5,000 subscribers, forming part of a system similar to that existing in London, there would be 1,000 junction wires, say, 500 outgoing and 500 incoming. The latter would necessitate the provision of five extra sections, thus bringing the total to 30 sections, whilst the former would involve the use of 500 additional jacks on each section, making the total number of jacks 165,000.

It will thus be seen that a multiple board for 5,000 subscribers' lines is a huge electrical equipment. The number of soldered joints on such a switchboard, in connection with the jacks alone, is nearly a million, and the total length of wire is between 1,500 and 1,600 miles.

The largest switchboard we have in this country is one which has been provided for taking the total number of jacks required for 8,400 subscribers' lines—*i.e.*, including junctions, 9,000 line jacks on each section—and for such an exchange, fitted on the ordinary multiple system, there would be required a total of 432,000 line jacks; so that, while we have only increased the number of subscribers' lines from 5,000 to 8,400 (*i.e.*, 68 per cent.), we have increased the number of multiple jacks required from 165,000 to 432,000, or 162 per cent.

In fig. 5, A, B, C, D, &c., represent a subscriber's line passing through separate sections of a switchboard. The wires come to the outer springs of jack A, and pass from the inner contacts to the outer spring of jack B, and so through all the sections. If the number of this subscriber's line is between 1 and 200, the wires, after passing

through all the sections, would return to section A, pass through the local jack, and end in the indicator. A third wire in connection with the barrels of the jacks is also carried through all the sections, and is normally an insulated wire. This is the test wire, by means of which an operator ascertains whether or not the line wanted is engaged at any other section.

When an operator replies to a subscriber, she inserts a plug into the jack of his line. The tip and ring of the plug connect to the line wires, and the sleeve joins the barrel of the jack to a battery, the other side of which is connected to earth or a common return. To complete the connection, the jack of the line wanted is similarly treated. Should either of these subscribers now be asked for at another section of the board, the operator there would touch the barrel of that subscriber's jack with the tip of the plug with which she proposed to make the connection, when a current would pass from the test wire through her telephone, causing a click, and so advising her that the line was engaged.

The spring jacks are made up in strips of 20, mounted on two parallel pieces of vulcanite $1\frac{3}{8}$ inches apart. I submit a sample strip of these jacks. The front piece is $11\frac{1}{2}$ inches × $\frac{1}{2}$-inch × $\frac{1}{4}$-inch, and the distance from centre to centre of the jacks is half an inch. The back part is slotted, and the springs which fit into these slots are shouldered, so that they cannot be forced out of position by the plug. Each jack has two long springs to which the line wires are connected, and these grip the plug. These springs rest on shorter springs (both being provided with platinum contacts) which are connected to the corresponding jacks in the succeeding sections of the board, and, lastly, to the local jack and indicator. A strip of metal is connected to the barrel of the jack, and is carried to the back as a soldering tag, and to this the test wire is attached. These strips are secured to stiles in the upper portion of the board by special fasteners which allow of any strip being readily withdrawn for repairing purposes.

I have here a sample showing how one row of jacks is connected by cable with the corresponding row in the succeeding section of the multiple.

The wires are carried throughout the switchboard in 63-wire cables, each cable serving 20 subscribers or one strip of jacks, and having three spare wires to provide for breakages. The copper conductor is No. 22 gauge, insulated with rubber and paraffined cotton. The wires

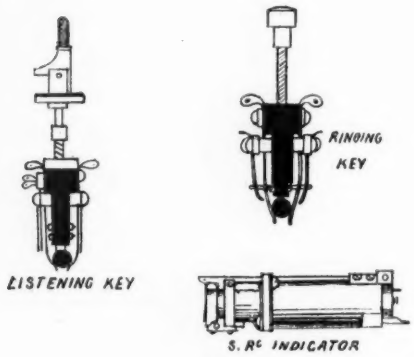


Fig. 3.

are laid up in threes—two line wires and one test wire for each subscriber. Seven such strands are twisted together, and three such groups of wires are laid side by side and covered with cotton braiding saturated with paraffin. The size of the finished cable is about $\frac{7}{8}$-inch × $\frac{3}{8}$-inch.

The listening and ringing keys, and their connections, are the same as those shown with reference to small boards.

The operator's telephone has received considerable attention of late years. It was, until lately, the practice to suspend the transmitter from the top of the board, and the receiver had to be held to the ear by hand. Now, the transmitter is fitted in an aluminium case, which is fixed to a light breast-plate of the same metal, and this is suspended round the neck of the operator, so that the mouthpiece is always conveniently placed for talking into. The receiver is also made up in a light form, and kept against the operator's ear by metallic springs or an elastic band. By the use of these instruments both her hands are left free for operating. The induction coil of the transmitter and the coils of the receiver are differentially wound, and the centre point of the latter coils is joined to earth to allow of the "engaged" test being obtained, and of the operator working earth circuit and metallic circuit lines on the same board indiscriminately. The earth being connected to the centre of the differentially wound coil has no detrimental effect on a metallic circuit line.

The boards just described are complete metallic circuit boards, and are used very extensively in this country. They work satisfactorily on earth circuits, and, if necessary, may be employed on earth circuit systems as transition boards. When on this system metallic circuits are joined to other metallic circuits they form a perfect metallic loop, but when joined to earth circuits one side of the metallic circuit is earthed at the exchange; the circuit so formed being but little better than a line with earth return throughout, the second line simply acting as a screen to lessen induction. All these connections are made in an exactly similar manner, the operator not having to distinguish between single and metallic circuits.

The problems in switchboard work have always been, firstly, How quickly can a connection be made? and, secondly, How can efficiency be best obtained?

With reference to the first, the desired end is attained by reducing to a minimum the number of movements necessary, and making those movements as easy as possible.

With reference to the second condition, in the earlier boards it was usual to leave the two line indicators in circuit when the lines were joined together; and the first step taken to improve this was to cut one out, or to cut out both line indicators, substituting a special indicator for the purpose of receiving the subscriber's clearing signal. The electro-magnet of this indicator was, however, directly in the circuit. It was observed that any such electro-magnet in the line circuit cut down the talking very considerably, one indicator having probably as much effect in reducing the efficiency of the speaking as 50 miles of an ordinary aerial line. The next step was to increase the resistance and self-induction of the ring-off indicator, and place it in shunt across the two lines of a metallic circuit, or as a tap to earth on single lines. It has also been found that trouble was sometimes caused by dirty contacts in the spring jacks. To obviate this difficulty some of the later boards have all the spring jacks wired in parallel, and the two line indicators, which are of special pattern, left in shunt. This system is sometimes called the "self-restoring" and sometimes the "branching" system; but, as the latter name had been correctly applied to other systems which had preceded it, and of which this is an extension, I prefer to use the former term.

In this system the work of the operator is lessened, inasmuch as the shutter of the indicator is automatically restored in answering the subscriber. This allows the indicators to be placed at the top of the boards, where space is not so valuable, and the spring jacks to be placed lower, thus bringing a much larger number within easy reach of the operator, and materially increasing the ultimate capacity of the board. The general arrangement of this class of board is much the same as that previously described, except that, as just mentioned,

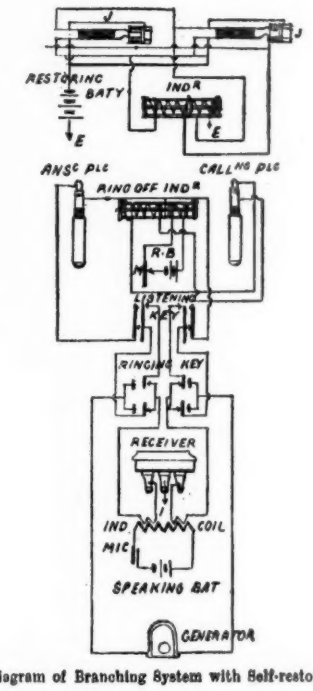


Fig. 4.—Diagram of Branching System with Self-restoring Indicator.

the indicators are placed over instead of under the spring jacks. The apparatus, however, is somewhat different. The springs of the jacks are let into a solid slab of vulcanite. There are three of these springs, two being of equal length and one shorter. The front of the slab of vulcanite carries two bushes, one behind, but insulated from, the other. The line wires are continuous throughout the exchange, ending at the subscriber's indicator. Branches are brought from these at each section, one to the short spring, and the other to the inner bush of the jack. The two springs of equal length are joined, one to a common battery wire running round the exchange, and the other to the corresponding springs of all the jacks in the same line, and, finally, also to the indicator. This latter spring is also in metallic contact with the front bush of its own jack. When a plug is inserted in a jack, the tip comes into contact with one line through the short spring; the sleeve, through the barrel, with the other line; and the two springs of equal length are connected by an insulated metallic ring between the tip and the sleeve. The tip and the sleeve are joined to the two conductors in the flexible cord used for connecting two subscribers.

The indicator consists of two separate single-coil electro-magnets, both sheathed with iron, and fixed one in front of the other. To the back one, which has a resistance of 1,000 ohms, the line wires are attached. The front one, which has a resistance of 45 ohms, is con-

nected on one side to the test circuit, and on the other to earth, or to the common return of the restoring battery.

When a subscriber calls, a heavy armature pivoted in front of the restoring coil is released, and falling forward a short distance, lifts a light aluminium shutter, disclosing the subscriber's number. When the operator inserts the plug to answer the subscriber, the heavy armature is drawn backward, and held fast in its normal position so long as the plug remains in the jack. The aluminium shutter, of course, resumes its normal position at the same time.

As before explained, the front bush of each jack is connected to this restoring circuit, and the connections of the operator's instrument are so arranged, that, when she touches this bush with the tip of one of her plugs, part of the current is shunted through her receiver, showing her that the line is engaged. As one of the connections is dependent upon the contact between the inside of the bush and the sleeve of the plug, which must fit somewhat loosely, the plug is provided with what we call "umbrella" springs. The ring-off indicators are of the same pattern as those above described, but are so arranged in connection with the listening keys, that when the operator's instrument is in circuit, the indicator is locked, but is free to respond to the subscriber's ring-off current, when, by pushing the lever forward, this instrument is cut out of circuit.

This class of board, with self-restoring indicators, is being introduced into London at the same time as the subscribers' lines are being metallic-circuited, and this work will be entirely finished in a few months. One of the principal exchanges fitted with this class of board is that at Lime Street, City.

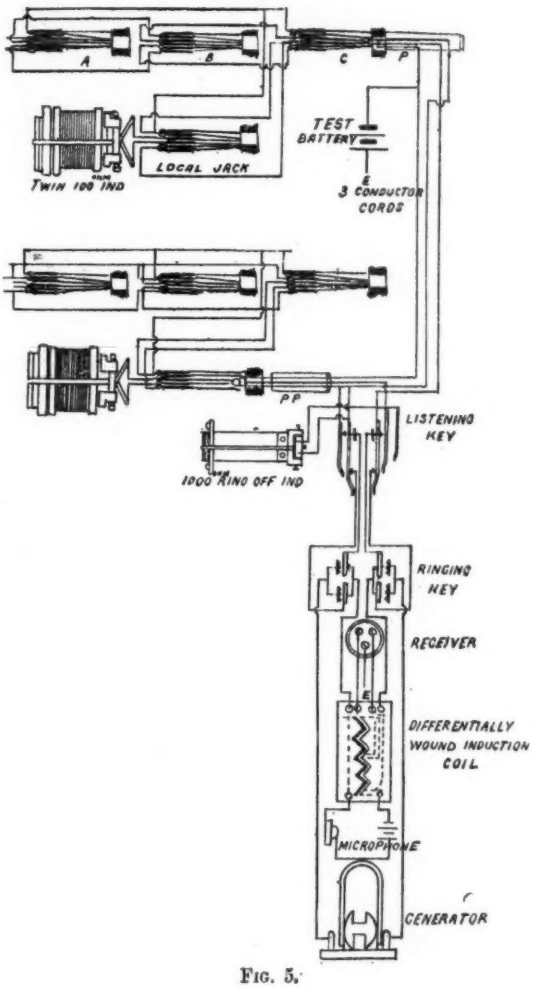


FIG. 5.

It is to be noted that, as these self-restoring indicators require permanent current to keep them locked while the lines are in use, special arrangements have to be made at each exchange for providing this current. As a typical case, I may mention that at Lime Street, the current is supplied by 12 E.P.S cells of 23 L type, charged by an Elwell-Parker dynamo running at 800 revolutions, and giving an output of 45 amperes at 15 volts. This dynamo is driven by a Tangye gas engine of 1 H P. nominal. The engine also drives the generators which supply the ringing current. One-half of the cells—*i.e.*, six—are in use at one time, arranged in three groups of two each, and each group supplies current for one-third of the whole exchange—*i.e.*, about 1,300 indicators. The current for the operator's transmitters is supplied by a similar number of cells divided in the same way. In this case each group supplies current for about 30 transmitters. To prevent overhearing, it is found essential that the circuit of each transmitter should be taken separately by direct leads from the terminals of the batteries. A duplicate set of cells is provided, and one set is being charged whilst the other is in use.

From what has previously been said as to the number of jacks required for an exchange with 5,000 subscribers' lines, and the increased proportion in the number required when the exchange is fitted for 8,400 lines, it is evident that, apart from cost, the question is a very serious one; indeed, it becomes so serious, that while on every hand it is acknowledged—and I think rightly acknowledged—that the multiple system is the best, a point may be reached where the vast number of jacks and large quantity of cables used introduce troubles almost equal to those previously overcome by the use of the multiple board. In America they are trying to meet the difficulty to some extent by the introduction of what is known as the "divided multiple" board, whilst I have endeavoured to meet it by the use of flat boards. The weak feature of the divided board is, that no connection is made without being dealt with by two operators, and, consequently, the chief advantage of the multiple system—viz., that the operator who receives a call completes the connection—is lost. But with the flat board, fitted as I shall presently describe, this advantage is retained, whilst, broadly speaking, one-half only of the line jacks and cable are needed.

It is about eight years since I commenced the use of flat boards, when a small one was fitted at Paisley. The working of this board proved that the flat board as a system, if fitted with the proper material, could be worked very successfully. I am aware that flat boards had been tried in this country before that date, and that some were in use in America; but, so far as I can learn, the number of jacks used was not less than that on the ordinary upright board. I therefore cannot see the reason for introducing them, unless, indeed, it was considered they were better flat than upright from an operating point

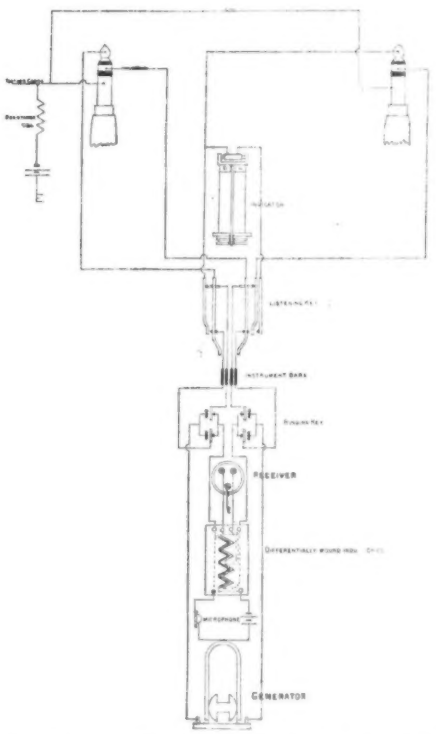


FIG. 6.—DOUBLE CORD CONNECTIONS FOR SELF-RESTORING INDICATOR.

of view. I am aware that there are in this and in other countries telephone engineers of the highest reputation who are not at one with me on the question of the advisability of introducing flat boards; but, after the fullest and most mature consideration, and experience of their working for several years, I see no reason why they should not be used largely under certain conditions. When flat boards are fitted up in comparatively small exchanges, the saving on the jacks and cable is not equivalent to the extra expense of the framework, and therefore I do not recommend their use for small exchanges. But for large exchanges with from 2,000 to 8,000 subscribers' lines there is, in my mind, no doubt that this is the best class of board to use.

The principal reasons for this opinion are:—

1. That, in consequence of the smaller number of jacks and quantity of cable used, better speaking results are obtained, and fewer faults occur. I have only to point out to you, as electrical engineers, that for an 8,000-line exchange the number of soldered connections is reduced in the flat, as compared with the ordinary upright board, by over half a million, to bring this point of efficiency forcibly before you.

2. In many cities it is very difficult to find switch-rooms large enough to take from 5,000 to 8,000 subscribers' lines; but with the

flat broad system this difficulty does not exist to the same extent, as practically they take only half the floor space required for upright boards.

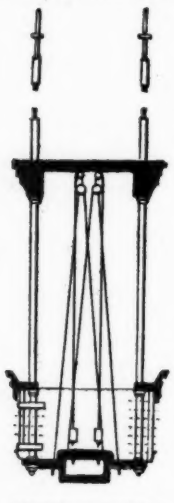
There are likewise the questions of the cost of the boards, rent of switch-rooms, lighting, heating, &c., which bear some proportion to the space occupied; but these are secondary considerations, the principal one being efficiency.

I should like to make it perfectly clear that, while I consider flat boards the right pattern to use under certain conditions, I do not recommend their use in all circumstances. With self-restoring indicators, which do not require to be within reach of the operator, and may consequently be placed overhead, and the jacks for use with which have no breaking contacts, with the consequent trouble arising from dust, I consider them the right class of board to use. I also consider the flat board the best to use in connection with exchanges of all sizes worked on the call-wire system.

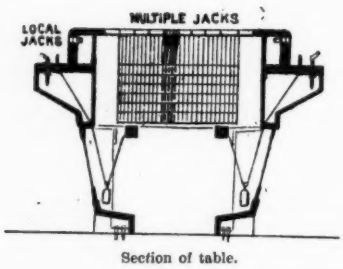
Fig. 6A shows a section of the type of flat board with self-restoring indicator before referred to. It will be seen that when a plug is inserted into a jack the springs of the jack do not break any connection, and when the plug is withdrawn there is no contact point to be restored.

The table carries the multiple spring jacks, the barrels all facing upwards. The local, or home section jacks, which are always used when answering subscribers, are at the side on the upright. The listening and ringing keys are fixed on a shelf at the side of the table, one half of the cords and plugs being fitted on the same shelf, and the other half in a canopy above the table, which canopy also carries

Flat board with self-restoring indicators.



SECTION OF CANOPY



Section of table.

FIG. 6A.

the self-restoring indicators. The lower plugs are the answering plugs, and are inserted in the lower jacks only; the overhead plugs are used only for making connection with the line jacks on the top of the table. The operators, each working 50 subscribers, sit on both sides of the flat table; and the 6 feet 6 inches section of multiple jacks, which, on the upright board, is common to four operators with 200 subscribers, is here common to eight operators working 400 subscribers. The framework is built of T and L iron faced with wood, the details being as shown by sectional drawing at fig. 6. Vertical oblong iron frames cross the tables at regular intervals of 11½ inches for carrying the jacks and cables. The ends of the strips of spring jacks rest on, and are fastened to, the upper edge of these frames, the jacks being placed in a vertical instead of a horizontal position. The cables are carried by racks inside these frames. Each block of 100 jacks occupies a space of 11½ inches × 2½ inches, and as there are six such blocks in the length, and 10 in the width of the multiple, it will be at once seen that the board has a capacity of 6,000 lines. A special type of 63-wire cable is used. The cable is formed of seven groups of three strands of three wires each, laid side by side, and covered with braided cotton, the external dimensions of the cable being 1·312 inches × 0·260 inch. The canopy is hung from the ceiling by rods at 3 feet 3 inches centres, and, as before mentioned, carries the indicators and half of the connecting plugs and cords. The strips of indicators are fixed in the sides of this canopy, being hinged to allow of their opening outwards for convenience of inspection and repairing.

In connection with flat boards I mentioned the call wire, and this introduces us to a system of working telephone exchanges differing largely from any I have previously described. The use of this system has been very much discussed by telephone experts. In the call-wire system, each subscriber has, in addition to his direct line to the exchange, the use, in common with a number of other subscribers, of a wire known as the "call wire," which, starting from the exchange, is branched into the offices of, say, 50 subscribers. On this call wire, the operator attending the subscribers is continuously listening in the exchange. The subscriber's instrument is fitted with a switch which enables him to place it in connection with the call wire, on which he asks for the subscribers he requires. These, of course, are connected on his direct wire, and are rung up by him, the operator not interfering with the connections until told on the call wire to clear. It will be seen from this that, when a subscriber takes a long time to answer his bell (and there are many of them who do so, especially in London), he has to explain to the calling subscriber the reason of the delay, which would, in all probability, have been otherwise attributed to the operator. There being 50 subscribers connected to the telephone of each listening operator, it is evident that any number of them may try to speak at the same time; but here, as in all matters of business, common sense, as a rule, prevails, and a subscriber coming on to the call wire and hearing others talking to the operator does as he would do if booking a ticket at a railway office—*i.e.*, takes his proper turn—and so the calling is done without confusion and more quickly than with the indicator system. It must be clear to everyone who considers the matter that an operator cannot attend to two subscribers at the same time; and, generally, it is quite as satisfactory to a subscriber to listen until he hears that the operator is free, as to ring time after time until the operator is able to attend to his call. It must be obvious, however, that the number of subscribers a call wire will accommodate is limited, and, as hereafter explained, great confusion would arise from overloading it.

Curve showing calls at Manchester Central Exchange for one day.

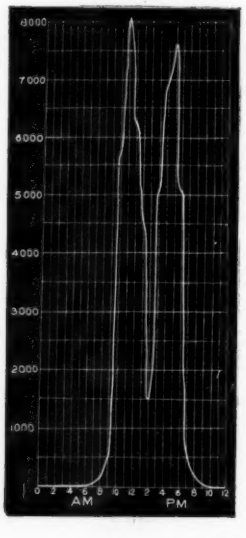
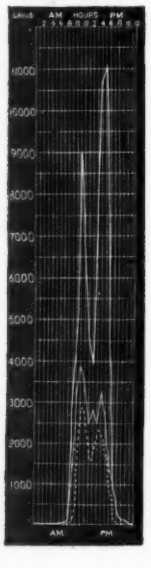


Diagram showing originating calls.



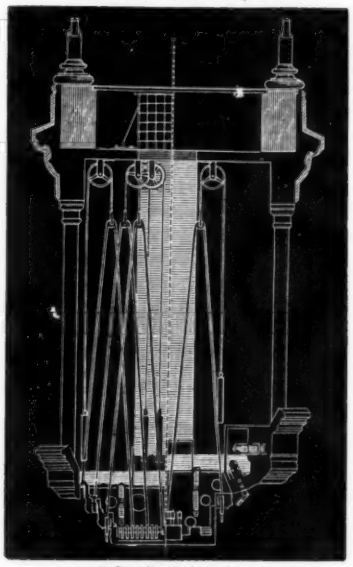
CURVES.

I have before now been accused of something like inconsistency in advising in favour of this system in some places, and against it in others. In deciding upon any particular case the local circumstances have to be taken into consideration, and, after a careful study of the subject, the decision I have arrived at is that, given a town where all, or nearly all, the subscribers' lines terminate in one exchange, there is no doubt that the call wire gives the most perfect service. For this reason we have introduced the call wire into Glasgow and nearly all the towns in Scotland. We are also introducing it into Manchester. It would, however, be absolutely unworkable in London. The full explanation of this would take more time than can be given to it in a paper of this kind; but, broadly, it may be said that in a great city like London, where there are a large number of exchanges, and consequently the subscribers' lines terminate at a number of different centres, the call-wire becomes unsuitable. Let us take an instance. Suppose a subscriber on our King's Cross exchange, whose office has been fitted with the call-wire, wishes to communicate with a subscriber on Lime Street exchange, in the City, he presses his call-wire key, and gives the listening operator the number of the subscriber he requires. The operator has then to do one of two things; she has either to cut herself off from the local call-wire, in which case the main feature of the call wire, viz., continuous listening, is sacrificed, or to connect her telephone, as well as the call-wire with its 50 subscribers, on to a call-wire to the City. Other operators in the same exchange may have been asked by their subscribers for subscribers in the City, and may also have connected their call-wires to the same City wire. In the event of a connection having to be made through two or three exchanges, this trouble would be increased, and it would often be found that operating would be rendered impossible, owing to the large number of subscribers connected together all clamouring

for their instructions to be taken first. The effect would be somewhat similar to that of a crowd of people attempting to rush out of a public building, on an alarm of fire, through a doorway too small to accommodate them; they simply get jammed in the doorway, with the unhappy result that they perish in the attempt. In the same way the subscriber at King's Cross might stand at his instrument and perish before he succeeded in getting through to the subscriber in the City. With this explanation it will, I am sure, be apparent to everyone who thoroughly studies the matter, how it is that the call-wire may be successful at one centre where all, or nearly all, the subscribers' lines are grouped in one exchange, and be a complete failure if introduced into an exchange system like that of London.

All things being considered, we find that the call-wire gives more satisfaction than the indicator system, and it is perhaps to be regretted that it cannot be introduced under all circumstances. We had the indicator system with multiple boards at work for many years at Glasgow, and we changed to the call-wire system. Nine months after the introduction of the new system, the subscribers were asked whether they preferred the call wire or the indicator

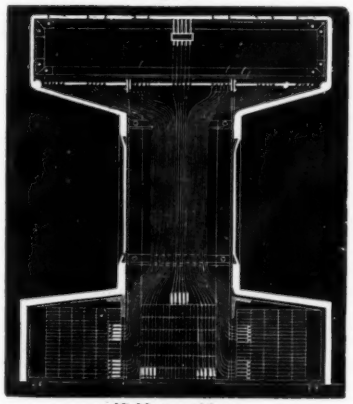
Flat board for call wire system



Subscriber's junction.

Sections of Canopy.

Multiple jacks.



Cable troughing.

Section of Table.

Fig. 7.

system previously in use, with the result that 95 per cent. of the subscribers were in favour of the new system; and it was this result that decided the question in favour of its introduction into Manchester.

The call wire has been in use almost since the introduction of telephone exchanges, and here again I find that our friends on the other side of the Atlantic at a very early date saw the advantages to be derived from it, with both the make-and-break and the branching system. It is the latter system which is being introduced at Manchester.

It so happens that at Manchester 90 per cent. of our subscribers have their lines terminating in the central exchange, and, consequently, it is a highly suitable place for the introduction of the call-wire system. We are now installing it there in connection with a new exchange which is being fitted with flat boards.

The Manchester board differs somewhat in detail from that with self-restoring indicators which has been already described. The board will accommodate 7,200 subscribers' lines, and is now being fitted complete for 4,800, with the necessary trunk and junction wires in addition. The design of the framework has been so modified as to allow the operators to get nearer to the line jacks, which gives greater facilities for operating.

I may now refer to a few load curves I have prepared showing the number of calls passing through our busiest exchanges. At the top of these we find Liverpool, where the average number of calls per subscriber per day amounts to 18·6. The pressure of the work will, however, be better understood by noticing that at certain hours of the day the number of calls is very high. For instance, between 4 p.m. and 5 p.m. the average is 11,050. I believe this is a higher average than is to be found in any other exchange of equal size in this or any other country.

An important part of an exchange system in a place like London is the proper arrangement and working of the junction wires between the different exchanges. I have found that the best way to arrange these is to have, in addition to the direct wires, a central junction wire exchange, between which and every other exchange two or more wires are provided. It will be readily understood that in a system like that of London, where there are 37 exchanges, it would be impracticable to run from each new exchange opened in the suburbs direct wires to all the others. Therefore the central junction exchange becomes a necessity. It is obvious, however, that such a central exchange must introduce extra operating, and consequent delay, into the service; and, therefore, where we have as many as 60 or 70 messages per day between any two exchanges, we provide two direct junction wires. Beyond this, an additional junction wire is provided for each 40 messages per day. Taking the average duration of each call as three minutes, it will easily be seen that, to meet the maximum pressure at the busiest time of the day, so many junction wires have to be provided that the average time each is in use amounts to only two hours out of the 24.

Physical Society.

Ordinary Meeting, March 27th, 1896. Prof. Carey Foster, Vice-President, in the chair.

Prof. J. A. Fleming read a paper on the "Edison Effect."

The Edison effect alluded to in the title of the paper is that if a metal plate is placed inside the loop of an incandescent lamp, then a galvanometer, of which one terminal is connected to this metal plate and the other to the positive lead of the lamp, will indicate a current passing from the lead to the plate. If, however, the galvanometer is connected to the plate and the negative lead no current passes. Prof. Fleming by connecting the poles of a condenser, first to two leads, secondly to the plate and positive lead, and, thirdly, to the plate and negative lead, and in each case discharging the condenser through a galvanometer, has shown that after the lapse of a certain time depending on the position of the plate, if the lamp is working at about 4 watts per candle, the potential of the plate falls to that of the negative lead. If the plate, instead of being inside the loop of the filament, is outside, then the time taken by the plate to acquire the potential of the negative lead is considerably longer. The space between the plate and the negative lead exhibits a kind of unilateral conductivity, for a battery having a low voltage is able to send a current from the plate to the negative lead, but not in the opposite direction. If, instead of using a cold metal plate, a second filament, maintained in a state of incandescence by an insulated battery, is used, then a current can be obtained between this filament and both the positive and negative leads. If the voltage on the lamp is raised considerably above that required to give 1 candle-power for 4 watts, then a current can be passed from the plate to the negative lead, while a galvanometer connected to the positive lead, and the plate will indicate the passage of a current from the positive lead to the plate. When the lamp is in this condition the space between the plate and the negative lead is very sensitive to the effects of a transverse magnetic field, such a magnetic field causing a large increase in the resistance. The curve showing the connection between the current passing from the positive lead to the plate, and the volts between the terminals of the lamp is found to be discontinuous. As the volts are raised the current suddenly increases about tenfold, and it is while the lamp is in the condition corresponding to this upper portion of the curve that it is sensitive to the influence of the transverse magnetic field. By using a movable plate it has been found that the minimum current is obtained when the plate is nearer the positive than the negative lead. When an alternating current is used to supply the lamp a continuous current can be obtained passing from the plate to either of the leads. If a small platinum cylinder is placed surrounding each of the leads, then a current can be obtained between each of the cylinders and the positive lead, but no current between the two cylinders. The largest effect occurs when a cylinder near the end of the negative lead is connected to the positive lead. The author considers that his experiments show that the resistance of a vacuum tube to the passage of a discharge would be greatly reduced if the cathode is made incandescent.

Prof. S. P. Thompson said he would like to have some information as to the state of exhaustion of the lamps; whether this was such as is found in ordinary commercial lamps, or whether it more nearly approached that used by Crookes. A great change in the conductivity, &c., took place, at an exhaustion slightly greater than that ordinarily found in incandescent lamps. It would be of interest to vary the size of the cathode, and to investigate whether the magnitude of the effects observed depended on the fall of potential per unit length along the filament. Another point was whether the position of the plate, for which the effect was a minimum, was the

same for all lamps, or whether it changed with the volts and the length of the filament employed. Again, did the minimum occur at a certain fraction of the distance between the positive and negative leads, or, as was the case in some of the phenomena observed by Crookes, at a definite distance from either of the leads? These points might be investigated by means of a lamp with a straight filament, where the fall of potential per unit length along the filament might be the same as with the loop-shaped filament, but the fall of potential per unit length in the vacuum would be different. The author's proposed experiment of heating the cathode by concentrating on it the rays of a lamp, did not seem to him (Prof. Thompson) to differ materially from Crookes's experiment, in which an incandescent wire, heated by a current, was used as the cathode.

Mr. Skinner said that the heating of the cathode by means of a "burning-glass" could easily be carried out.

Mr. Blakesley pointed out that it would be quite possible to produce an increase of the current by means of a magnet.

Mr. Seble said that Professor J. J. Thomson had shown that a magnet affected the conductivity of a gas.

Prof. Fleming, in his reply, said that no doubt the effects were largely dependent on the vacuum in the lamps. The lamps employed were exhausted to the ordinary commercial vacuum. Since it was found that the "treating" was more worn off the negative leg of the filament, and that a screen placed between the legs of the filament was more blackened on the side turned towards the negative leg, it would appear that the particles of carbon were shot off from the negative leg, and hence, perhaps, the charge was carried by these carbon molecules.

A paper of a purely mathematical character, entitled Notes on the Electro-magnetic Effect of Moving Charges, by Mr. W. E. Morton, was read by Mr. Seble, who also made some remarks on his own investigations dealing with this subject.

The Society then adjourned till April 24th.

KAMM'S TELEGRAPHIC TYPEWRITER.

This instrument is practically a typewriter combined with a telegraphic transmitter and receiver, so arranged that the ordinary action of the fingers on the keys prints the message in front of the operator's eyes, while at the same time an exactly similar instrument at the end of the line automatically reproduces the same signs. The operations are as follows:—A key is depressed: this allows a current from a local battery to disengage a balanced pendulum (geared to a type-wheel) by means of an electro-magnet, both in the operator's machine and in the machine at the far end; at the same time, by means of another magnet, a stop is raised which regulates the distance to which the pendulum, and consequently the type-wheel, can move. Upon the pendulum touching the stop, at both stations simultaneously, it brings another electro-magnet into action to strike the paper and record the desired symbol.

This is practically the instrument. There are various additions and details, such as the electrical arrangement which disengages the carriage and allows it to restart at a new line, &c.

Says Mr. Kamm in a prospectus with reference to the apparatus:—

"Since the introduction of electric telegraphy, numbers of inventors have endeavoured to perfect an instrument which would enable operators to print a telegram at a distance in Roman type instead of by 'dots' and 'dashes;' but few have been even moderately successful; the best known and most reliable instrument is that of Prof. Hughes, invented in 1855, but it is expensive, and it has the drawback of clockwork and motors. Another aim of inventors was to have an instrument which did not require trained knowledge in its use. The old A B C instrument, which is slow, and has other drawbacks, is the resulting instrument most commonly used. A third desideratum, hitherto uncatered for, has been an instrument which could be satisfactorily used on an exchange system, as telephones are used. Kamm's telegraph typewriter combines the whole of the above advantages. The telegram is printed at the further end of the line, say, 4,000 or 5,000 miles away (!) as a bold typewritten document, the machine automatically starting a fresh line when required. There are no cogwheels, clockwork, or motors, to get out of order; the mechanical working parts of the instrument being as simple as those of a typewriter, whilst the machine can be made and sold with a good profit at less than half what the Hughes sells for. Electro-magnets, and the fact of striking the keys, supply all the necessary movements. The instrument looks rather like a large typewriter, the keyboard being similar, so that no skilled knowledge is required, and even a child can send a telegram without training."

Although the apparatus displays great ingenuity, we cannot agree that it can be called a simple apparatus; on the contrary, it is in our opinion decidedly complicated, and, moreover, it is very slow in its action. A great mistake is made in comparing it with the Hughes instrument, which it in no way resembles. The apparatus is really a very complicated form of "column printer," and is far slower and must be, we consider, less reliable in its action than the latter form of apparatus. Mr. Kamm is confident that he can increase its rapidity of action, but we fail to see, even if this is effected, in what respect the instrument is superior to the ordinary column printers, say of the Exchange Telegraph Company or the Central News. We shall, however, wait with interest the development of the apparatus, which, we repeat, is certainly ingenious, and Mr. Kamm is an expert mechanician.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Compiled expressly for this journal by* W. P. Thompson & Co., *Electrical Patent Agents*, 322, *High Holborn, London, W.C., to whom all inquiries should be addressed.*]

NEW PATENTS.—1896.

6,374. "Improvements in electric traction." D. Korda and A. G. New. Dated March 23rd.

6,397. "Improvements in conduits applicable for wires for conveying electricity." J. J. Bate. Dated March 23rd.

6,423. "Improvements in electric switches." W. H. Dingle and J. M. Urquhart. Dated March 23rd.

6,437. "Improvements in and relating to current-collectors for electrically actuated tramway vehicles with underground feed." H. H. Lake. (Union Electricitats Gesellschaft, Germany.) Dated March 23rd. (*Complete.*)

6,477. "An improved cord grip for electric light fittings." G. O. Donovan. Dated March 24th.

6,481. "Improvements in apparatus for supplying electricity to electrically propelled vehicles on railways and tramways." A. Megroz. Dated March 24th. (*Complete.*)

6,487. "Improvements in controllers for electric motors." J. Devonshire. (E. D. Priest, United States.) Dated March 24th. (*Complete.*)

6,504. "Improvements in electrically illuminated devices for advertising purposes." J. Lengyel and A. Schlesinger. Dated March 24th.

6,509. "A process and apparatus for decomposing sodium or potassium chloride and generating electricity." L. Epstein and F. Marza. Dated March 24th.

6,510. "An improvement in electric arc lamps." J. Brockie. Dated March 24th.

6,524. "Improvements in electric counters." F. G. Robinson. Dated March 25th.

6,549. "Carbon-holder for dynamo rubbers." F. J. Head. Dated March 25th.

6,576. "Improvements in microphones." P. Hardegen. Dated March 25th. (*Complete.*)

6,579. "Improvements in telephonic apparatus." A. Graham. Dated March 25th.

6,606. "An electric cyclometer." T. G. Smith. Dated March 26th.

6,692. "Improvements in or connected with fusible electric cut-outs." A. B. Blackburn and W. L. Spence. Dated March 26th.

6,732. "Improvements in and connected with advertising devices operated by an electrical current." J. H. Collings. Dated March 27th.

6,864. "Improvements in short-circuiting or safety devices for overhead electric conductors." G. A. Jewett. Dated March 28th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Copies of any of these Specifications may be obtained of* Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., *price, post free,* 8½*d.* (*in stamps.*)]

1895.

18,038. "Improvements in and appertaining to electrodes." H. Leitner and E. Reicher. Dated September 26th, 1895. One electrode is formed of a vulcanite staff supporting a leaden tube on which is deposited pure zinc. The other electrode forming the casing is composed of a carbon tube lined with a tube of peroxide of lead. The whole cell is enclosed in a cell of celluloid, ambroin, &c. 1 claim.

1896.

207. "Improvements in electric arc lamps." W. P. Thompson. (The Electric Arc Light Company, New York.) Dated January 3rd, 1896. The arc is provided with a transparent or translucent envelope or enclosure, provided with a gas check which affords egress for the gases developed by the arc and permits a limited supply of air to enter the enclosure. The regulating coils are in series with the arc, and act on an armature which operates a friction clutch and control the feed of the positive carbon. A small auxiliary resistance is placed in series with the lamp to produce a fractional drop of potential. 7 claims.

1,427. "Improvements in and connected with telephone apparatus." H. Marcuse. Dated January 21st, 1896. Relates to providing automatic means whereby on adjusting the receiver the speaking circuit will be substituted for the signalling circuit and *vice versâ*. The receiver is supported upon the end of an arm, to which it may be secured by an adjustable strap. The arm is mounted on a pivot connected by lugs to a disc which is rotatable to a limited extent. This disc has a can-like projection which, on the rotation of the arm forces out one end of a bell crank lever, the other end of which engaging with a hook, disconnects the signalling circuit to form the speaking circuit; on the restoration of the arm the reverse is effected. 3 claims.